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WINNIPEG DISTRICT HEATING STUDY

— PHASE I —

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MANITOBA/CANADA CONSERVATION AND RENEWABLE ENERGY DEMONSTRATION AGREEMENT

The availability of secure and affordable energy supplies is a subject of national concern. It is an accepted fact that our primary energy sources - oil and natural gas - are becoming less accessible and more costly. However, Canada is well-endowed with non-renewable and alternative resources that can provide a bridge into the future.

To this end, the governments of Manitoba and Canada have entered into a Conservation and Renewable Energy Demonstration Agreement which was signed May 9, 1980 and terminates March 31, 1984. The Agreement is dedicated to the development and demonstration of conservation and renewable energy technologies. Equally cost-shared by the provincial and federal governments, the program has a total budget of $18-million.

The objectives of CREDA are:

- To develop and demonstrate promising new technologies, which, when widely adopted, will exploit renewable resources, conserve energy and/or use energy more efficiently.
- To develop broad public awareness of the potential of renewable energy and conservation technology.
- To provide opportunities for the commercial application of the technologies within Manitoba.
- To create economic spin-off benefits for manufacturing, industry and commerce.
- To create employment in new or existing energy-related industries.

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EXECUTIVE SUMMARY

Expansion of the existing district heating system to serve the central area of Winnipeg and industries in St. Boniface area is technically feasible and economically viable. It is anticipated that the economic viability will be enhanced as more data becomes available and it is recommended that the City proceed with Phase II of the study.

This Phase I study was sponsored by the City, and Provincial and Federal Governments under CREDA, the Canada/Manitoba Agreement on the Development of Renewable Energy and Conservation Technologies. The study determines whether potential markets exist for the expansion of the existing system and whether they can be served at an acceptable price. Although a number of fuels have been considered, primary emphasis has been placed on municipal solid wastes as an energy source. Funds have already been allocated for a detailed Phase II study, which would follow if the results of this Phase I study are encouraging. A total of $720,000 has been allocated to Phases I and II. The City's contribution is $233,333. The Provincial and Federal funding, equally cost-shared, totals $486,667.

The system will use municipal refuse as the primary fuel, with savings of non-renewable fuels and reduction in landfilling requirements. It will result in a net reduction in heating costs to the existing and potential customers, among whom the three levels of government are the largest. Low cost steam will be available during the summer months and could attract industries to Winnipeg.

A market survey, covering the central area of Winnipeg, and adjoining industries and institutions, indicates a total market of 1,465 million lbs. of steam/year. This is broken down as follows:

Existing	=	400 million lbs/year
Additional Commercial	=	400 million lbs/year
Industrial/Institutional	=	665 million lbs/year

These figures are conservative. We believe that additional commercial markets could actually approach 590 million lbs., with industrial/institutional markets reaching 840 million lbs/year. All of the above markets can be developed at a savings of 20 percent of the existing fuel cost. Potential new markets to be developed under the core area program should be considered during the Phase II study.

The proposed system uses municipal solid waste (MSW) as the primary fuel and coal as the winter peaking fuel. The bulk of the steam is generated in threee 425 ton/day MSW incinerators and winter peaking steam is supplied by an upgraded Amy Street plant. The existing distribution system is uprgraded and expanded to serve the new markets. Capital cost of the new facilities and modifications to the existing system is estimated to be $100 million and operating costs are estimated to be $6.40 million per annum.

For this assessment, it has been assumed that the plant will be located at the City-owned Mill Street site but detailed investigations are required during Phase II of the study to select a final site. Generation of electrical energy using excess steam during summer months appears to be uneconomical and this low cost excess steam will be available for future industrial growth in Winnipeg.

Net present value of all costs for the Base Case is $175 million and value of benefits $226 million, resulting in a benefit/cost ratio of 1.29. If the range of accuracy of costs and some benefits is considered, the benefit/cost ratio is calculated to be in the range of 1.05 - 1.68. Benefits considered in this analysis include steam revenue, savings to various levels of governments because of the retention of the existing system, a lower steam cost for the new system and a reduction in the MSW hauling and land-filling requirements. A number of additional benefits are foreseen, but have not been investigated in detail at this stage of the study.

Plant revenues are based on a steam price of $6.13/1000 lbs. for industrial users and $6.74/1000 lbs. for space heating. These prices have been calculated on the basis of users' fuel costs and the savings they require in order to connect to a district heat system. These prices are substantially lower than existing prices, and will result in a net reduction in energy costs for the existing and proposed customers.

RÉSUMÉ ADMINISTRATIF

Il serait possible, tant sur le plan technique qu'économique, d'agrandir le réseau actuel de chauffage par district en vue de desservir la zone centrale de Winnipeg ainsi que les industries implantées dans la région de Saint-Boniface. Par ailleurs, il est probable que des données supplémentaires feront encore mieux ressortir la viabilité économique de ce projet, et nous recommandons que la ville entreprenne la phase II de l'étude.

La phase I de l'étude a été parrainée par la ville de Winnipeg et par les gouvernements provincial et fédéral dans le cadre du programme DEREE, l'Entente Canada-Manitoba de démonstration des économies d'énergie et des énergies renouvelables. L'étude permet de déterminer s'il existe des marchés potentiels à même de justifier l'agrandissement du réseau, et s'il est possible d'offrir un prix acceptable aux consommateurs. Bien que l'on ait envisagé d'employer divers combustibles, les déchets solides semblent s'imposer pour l'instant comme source d'énergie première. Des fonds ont déjà été prévus pour la phase II de l'étude qui sera entreprise si les résultats de la première phase s'avèrent probants. Une somme totale de 720 000 $ a été consentie pour les deux phases. La part engagée par la ville s'élève à 233 333 $, tandis que les gouvernements provincial et fédéral ont chacun versé la moitié des 486 667 $ restants.

Le combustible principal de ce système sera constitué de déchets urbains, ce qui permettra d'économiser les combustibles non renouvelables et de réduire considérablement les besoins en matière de dépotoirs. Les consommateurs présents et futurs, y compris les trois niveaux de gouvernement - qui sont d'ailleurs les principaux usagers - jouiront d'une réduction nette de leurs frais de chauffage. Un surplus de vapeur sera disponible, au cours de l'été, à un prix réduit, ce qui pourrait amener d'autres industries à Winnipeg.

Les coûts actuels de base s'élèvent en tout à 175 millions de dollars et les bénéfices s'évaluent à 226 millions, ce qui se traduit par un rapport coût/bénéfice de 1,29. Si l'on tient compte des variations possibles des coûts et de certains bénéfices, ledit rapport peut varier entre 1,05 et 1,68.

Les avantages considérés dans l'analyse comprennent : le revenu fourni par la production de la vapeur, les économies réalisées par les trois niveaux de gouvernement par suite de la conservation du système existant, le prix réduit de la vapeur engendrée par le nouveau système, la réduction du prix de transport des DSU et la diminution des besoins en matière de dépotoirs. Il y a d'autres avantages prévisibles, mais ils n'ont pas encore été étudiés en détail.

Le revenu de la production est calculé à raison de 6,13 $ par mille livres de vapeur pour les industries et à raison de 6,74 $ par mille livres pour le chauffage. On a calculé ces prix en se basant sur les frais de combustibles des usagers et sur les économies qu'ils doivent faire pour se brancher au système. Ces prix qui sont beaucoup plus bas que les prix en cours se traduiront chez les usagers présents et futurs par une réduction marquée des frais d'énergie.

Une étude du marché portant sur le centre-ville de Winnipeg et sur les industries et établissements adjacents évalue la consommation annuelle à 1 465 millions de livres de vapeur par année. En voici la ventilation :

Consommation actuelle	=	400 millions de livres par année
Besoins commerciaux supplémentaires	=	400 millions de livres par année
Besoins des industries et établissements	=	665 millions de livres par année

Il s'agit là d'une évaluation modérée. Nous estimons en fait que les besoins commerciaux supplémentaires pourraient approcher des 590 millions de livres et que la consommation des industries et des établissements collectifs pourrait atteindre 840 millions de livres par année. Il est donc possible d'exploiter ce marché en offrant une économie allant jusqu'à 20 % des coûts actuels de combustibles. Les nouveaux débouchés résultant du programme de centre-ville pourraient être considérés dans la Phase II de cette étude.

Dans le système envisagé, les déchets solides urbains (DSU) servent de combustible principal, mais on utilise aussi le charbon lors de la période de pointe hivernale. La plus grosse partie de la vapeur est produite au moyen de trois incinérateurs pourvus chacun d'une capacité de combustion de 425 tonnes de DSU par jour. L'usine modernisée de la rue Amy permet de satisfaire aux besoins accrus de la période de pointe hivernale. La modernisation et l'agrandissement du système actuel de distribution de vapeur sont adaptés au nouveau marché. On a estimé les dépenses d'immobilisation pour le réseau de chauffage recommandé et les améliorations au système actuel à 100 millions de dollars et les frais d'exploitation à 6,40 millions de dollars par année.

Dans cette estimation, on a supposé que l'usine serait située sur le terrain que possède la ville dans la rue Mills, mais il faudra encore faire une étude détaillée sur le choix final du lieu lorsqu'on en sera à la phase II. Il ne serait pas économique d'utiliser l'excès de vapeur des mois d'été pour produire de l'électricité, mais ce surplus à bon marché pourrait servir au futur développement industriel de Winnipeg.

1.0 EXECUTIVE SUMMARY

MARKET SURVEY AREA

FIG. 1.1

1.1 INTRODUCTION

Expansion of the existing district heating system to serve the central area of Winnipeg and industries in St. Boniface area is technically feasible and economically viable. It is anticipated that the economic viability will be enhanced as more data is available and it is recommended that the City proceed with Phase II of the study.

The above are the major findings of Phase I of this study which has been aimed at determining whether a detailed investigation into expanding the existing district heat system is justified. The City of Winnipeg has operated this system, serving the central area of the City since 1924. Steam is generated by a coal-burning plant at Amy Street and substantial capital expenditures are required to upgrade this system to current environmental standards, and to maintain it in a satisfactory operating condition. These capital expenditures are of sufficient magnitude to bring into question the viability of the existing district heating system. Location of the existing system is shown in Figure 1.1.

This Phase I study, sponsored by the City, and Provincial and Federal governments under the Manitoba-Canada Agreement on the Development of Renewable Energy and Energy Conservation Technologies, determines whether potential markets exist for the expansion of the existing system and whether they can be served at an acceptable price. Although a number of fuels have been considered, primary emphasis has been placed on municipal solid wastes as an energy source. Funds have already been allocated for a detailed Phase II study, which would follow if the results of this Phase I study are encouraging.

TABLE 1.1

COMMERCIAL MARKET
(Million lbs. steam/year)

		MARKET
1.	Eatons and Eaton Place	119
2.	Provincial Government System	96
3.	The Bay	50
4.	University of Winnipeg	32
5.	Convention Centre	46
6.	Great West Life	34
7.	Fort Garry Hotel	29
8.	Lombard Place	28
9.	Marlborough Hotel	27
10.	411 Cumberland	25
11.	Lakeview Square	22
12.	North Star Inn	19
13.	Grain Commission	17
14.	Trizec Building	14
15.	Colony Square	9
16.	Library	9
17.	Westin Hotel	9
18.	391 York	6
	TOTAL	591

1.2 MARKET

It has been shown that an additional market for steam in the order of 400 million pounds per year, can be developed for commercial buildings located in the central area of Winnipeg. Industrial and institutional markets are estimated at 665 million pounds per year. All ob the above markets can be realized at a saving of twenty percent or less over the existing fuel costs for each potential customer.

These conclusions are based on a market survey during which the total market for the downtown area was determined and major industrial and institutional customers identified within an "acceptable distance" from the facility. Personal interviews were then held with the major customers to solicit interest in purchasing steam from a central facility and to obtain their actual energy consumptions. The response from all selected customers was positive except one industrial customers. A number of small customers were also contacted, but it was quickly determined that small buildings would not constitute a market. Most of these have hot water heat systems and conversion costs will be high, requiring large savings in fuel cost to justify any change.

The commercial market is located in the area west-southwest of the existing steam heat system, presented as Western Extension in Figure 1.1. A total of 18 customers, with a demand range of 6 to 119 million lbs. of steam per year are identified in Table 1.1 with a total steam consumption of 591 million lbs/year. This study assumes that only 400 million lbs/year will be available to the expanded district heat system. This is considered to be a very conservative assumption, as only the public buildings, considered as firm markets, represent in excess of 40% of this market.

The industrial and institutional markets identified in this survey represent a total demand of 840 million lbs/yr as listed below:

	Million lbs. Steam/Year
Canada Packers	255
Burns Meats	155
St. Boniface Hospital	135
Other Packing Houses	120
Building Products	175
TOTAL	840

All of this market is available at a maximum equal to 20% of the existing fuel costs. This is a fairly firm market. However, we have assumed that one of the major customers will not be available to allow a margin of safety for the purposes of Phase I analysis. We have deleted Building Products at 175 million lbs/year, since the cost of the best route for steam supply pipe not be defined at this stage.

The net industrial/institutional market is thus 665 million lbs/year resulting in the following total estimated market:

	Million lbs. Steam/Year
Existing	400
New Commercial	400
New Industrial/Institutional	665
TOTAL	1,465

This market has been used for the conceptual design and financial analysis of the district heating system for Phase I of the study. In our opinion, additional commercial, industrial and institutional markets are available to the facility, and should be explored in detail in Phase II.

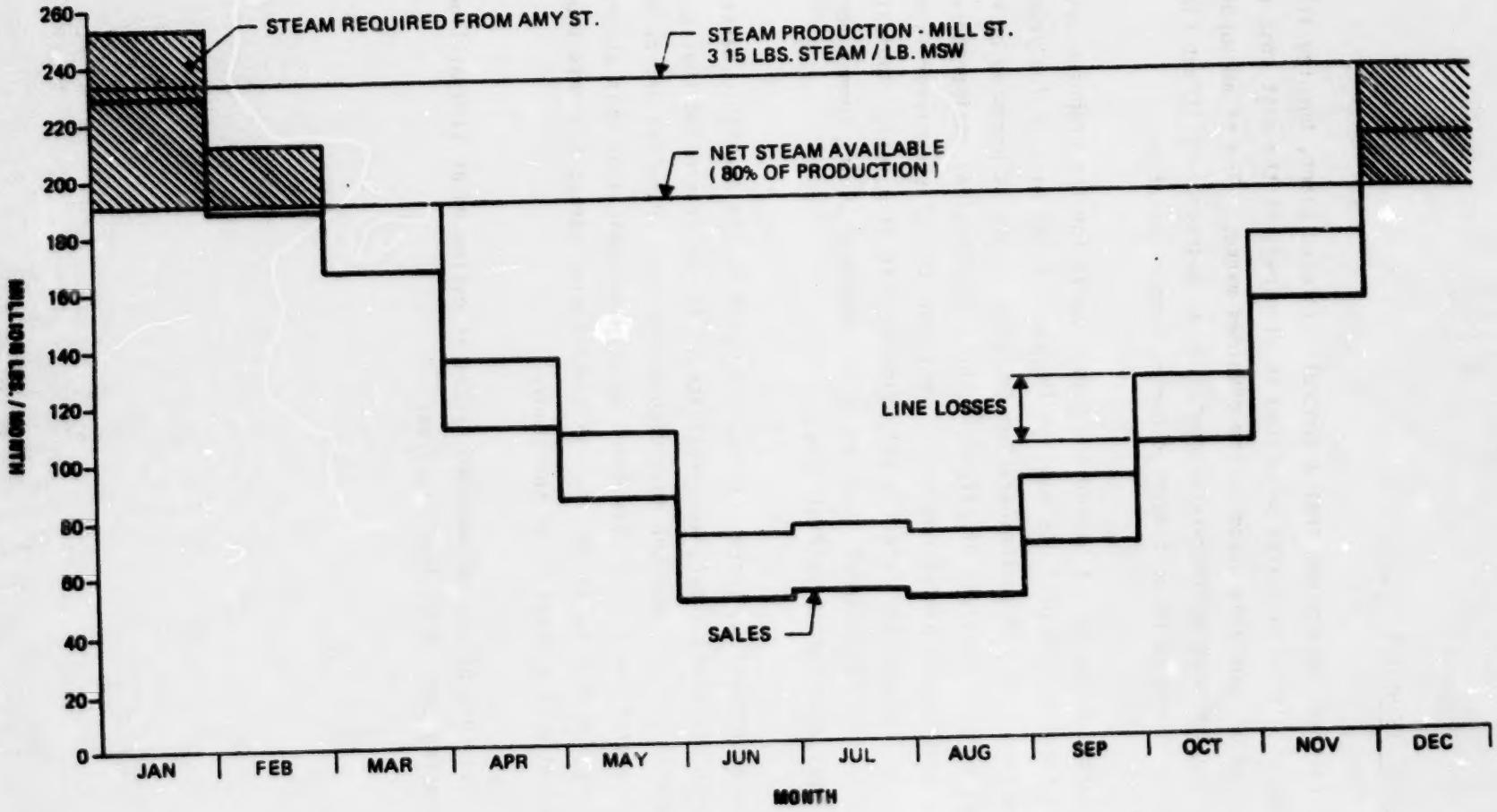
1.3 TECHNICAL

It has been determined that a centrally located plant, burning all combustible solid wastes generated in Winnipeg, is the most cost effective method of supplying steam to the combined market. The steam supply is to be supplemented during winter months by an upgraded Amy Street Plant. Excess steam is to be condensed during summer operation.

Figure 1.2 presents a demand and supply curve for the proposed system. Of the total demand of 1,465 million lbs/year, 1,345 million lbs/year is supplied by a refuse incineration facility. This is produced by mass burning 1275 tons/day of refuse in three 425 tons/day incinerators. During the peak demand winter months, 120 million lbs. of steam/year is supplied by the upgraded Amy Street plant using lignite as a fuel. Approximately 664 million lbs/year of steam is to be condensed during summer months and is available for industrial uses.

Four alternatives, three for supplying part of the available market and the fourth, discussed above, were evaluated. It was determined that supplying the entire market was the most economic option. Parallel and cogeneration of electric power were considered to be uneconomical at this stage. No effort was made to assess the air conditioning market and this should be studied during Phase II of the study.

Capital cost of the recommended system is estimated at $100 million, and operating cost at $6.4 million/year.



SYSTEM CURVE

FIG. 1.2

1.4 FINANCIAL ANALYSIS

An economic assessment of the proposed project, using the present value method of analysis, shows the project to be viable, with an expectation of improved viability as detailed data is developed during the second phase.

The present value benefit-cost ratio for the project is calculated at 1.29 for a 30-year operation. Present value of all costs is $175 million, and present value of all benefits $226 million. Costs include capital and operating costs of the incinerator, Amy Street plant and the distribution system. Benefits include the revenue from the sale of steam plus a number of savings to the various levels of government because of the avoidance of closing the existing system and the incineration of refuse instead of land-filling.

The range of accuracy of cost and some benefits results in a low benefit/cost ratio of 1.05 and a high value of 1.68. A number of additional benefits could be available to the system and have not been considered at this stage. These are expected to further enhance the project viability and should be investigated in Phase II of the study.

The current market price for steam has been determined to be $5.20 per thousand pounds based on 20% fuel savings of the more efficient users. This can be increased to $6.13 per thousand pounds, in 1982 dollars, when increases in gas and oil prices to 1986 are taken into account. Because of the lower efficiency of building heating systems than the industrial steam generators, 10% higher than average charges are assumed during winter months. These will be offset by 10% lower summer charges to compensate industrial customers. Despite these adjustments, the price is considerably below that presently charged to existing customers.

1.5 CONCLUSIONS

It is concluded that a district heating system to serve the downtown area of the City and adjoining industries, is technically feasible. Preliminary evaluation indicates the project to be economically viable, with a probability of improved viability as detailed data is developed. Other benefits of the proposed system are:

1. It uses municipal refuse as the primary fuel, resulting in savings of non-renewable fuels, and substantial reduction in landfilling requirements.

2. It reduces the net cost of heating to all customers, including the three levels of governments who will be the largest users.

3. It makes low-cost excess steam available during summer months, which could attract industries to Winnipeg.

1.6 RECOMMENDATIONS

We recommend that Winnipeg Hydro proceed with Phase II of the study which should focus on the following:

1. Development of detailed data on price, quality of steam, and potential contractural arrangements.

2. Confirmation of markets once the above data has been developed.

3. Detailed investigations into additional industrial and institutional markets to increase year-round and summer demands.

4. Optimization of the assumed scenario by taking into account in more detail:

   - Cogeneration
   - Chilled water supply
   - Condensate return versus cost of replacing water
   - A detailed review of standby and peaking systems, including use of other existing steam plants, or Boilers 1 to 4 at Amy Street, for peaking.
   - Use of alternative back-up fuels such as waste oils, Bunker C, etc.
   - Pipe sizing.
   - Detailed conceptual design of the incinerator, the Amy Street Plant modifications and the distribution system for more accurate cost estimation.
   - Investigations into hot water as the transfer medium.

5. Site selection based on economics, environmental accessibility, future riverbank development and other relevant criteria.

6. A detailed assessment of all possible benefits arising from a district heating system.

7. A detailed study of the existing and future cost of steam generation and hot water supply for potential customers.

8. Assessment of the value of steam to commercial and industrial users, and development of a pricing structure to encourage summer use of steam.

9. Preparation of a master implementation plan including financing, ownership and operation options. This should take possible staging of capital expenditures into account.

10. Socio-economic impacts of the facility caused by the shutdown of several existing steam generating facilities.

11. An assessment of the condition and use of the existing distribution system.

12. Evaluation of ancillary facilities for the disposal of hazardous wastes.

13. A detailed economic analysis of the facility.

2.0 MARKET STUDIES

MARKET SURVEY AREA

FIG. 2.1

2.0 MARKET STUDIES

2.1 INTRODUCTION

In order to determine the potential demand for steam available to an expanded distribution system, the approach has been to determine the total potential market in downtown Winnipeg and the surrounding area, and to identify the larger users. The area chosen for the survey is identified in Figure 2.1. Having identified the total market in the area, a survey of potential customers was undertaken to determine the level of interest and the price, relative to conventional fuels, that these potential customers would be willing to pay.

Because the existing Amy Street facility supplies steam to the existing customers and because most of the larger potential customers are currently using steam, it was decided to assume a steam distribution system for Phase I of the study. The reasons for this decision are dealt with in more detail in Chapter 3.0.

Buildings currently using hot water heating systems have been assumed to be potential users of steam. The cost of the necessary conversion equipment has been estimated and is identified in Chapter 3.0.

2.2 INITIAL MARKET REVIEW

A preliminary market survey has been undertaken in order to identify those areas where a detailed investigation and analysis should be carried out. The market has been separated into two segments.

- Commercial
- Institutional and Industrial

2.2.1 Commercial

Details of the area and height of 1,056 commercial buildings in downtown Winnipeg were supplied by the City and were analyzed by computer to identify probable heating requirements based on an average per cubic foot figure* found by Winnipeg Hydro to be representative of the existing load. This analysis ranked buildings in order of demand for energy in terms of equivalent pounds of steam, identified the type of heating system, and the source of energy.

The probable heating requirement of these buildings was calculated to be approximately equivalent to 2,000 million lbs. of steam per year. This includes the 400 million lbs. of steam per year currently supplied by the existing system but excludes those buildings currently heated by electricity which were not considered likely to be converted to steam.

2.2.2 Industrial and Institutional

Major potential institutional and industrial customers were interviewed by telephone. These were selected by our knowledge of the larger users in the market area. An approximate market of 2,230 million pounds per year was identified for these users.

Those major users who were, in our judgment, close enough to any of the potential sites to be serviced economically, were selected for personal interviews.

* 0.41 lbs. of steam per thousand cubic feet.

2.3 MARKET RESEARCH

2.3.1 Methodology

The objective of the market research has been to arrive at a realistic figure for the market penetration which can be achieved by a central steam distribution system, and to determine the price for steam which can be obtained for this level of penetration.

The major users were identified in the initial market review. The owners or managers of these buildings or industries were identified by a telephone survey. Mr. K. Hallson, P.Eng., General Manager of Winnipeg Hydro, wrote to those people explaining the purpose of the study and asking their cooperation in providing the necessary data. A copy of his letter is included in Appendix B.

Personal interviews were arranged with representative of the major users. Interviews were structured around a questionnaire prepared for this purpose.

Personal Interviews

Meetings with potential customers were informal. During the interview, the user's comments or the following topics were discussed in order to arrive at an overview of the basic criteria relevant to the user.

- The possible removal of the user's own heating plant and the consequent benefit in terms of space and operational manpower saving.
- The level of interest by the user relative to potential savings in energy costs.
- The user's perception of reliability of a district heat system in terms of price stability and security of supply.
- The average annual energy consumption for the building in question.

TABLE 2.1

COMMERCIAL MARKET
(Million lbs. steam/year)

		MARKET
1.	Eatons and Eaton Place	119
2.	Provincial Government System	96
3.	The Bay	50
4.	University of Winnipeg	32
5.	Convention Centre	46
6.	Great West Life	34
7.	Fort Garry Hotel	29
8.	Lombard Place	28
9.	Marlborough Hotel	27
10.	411 Cumberland	25
11.	Lakeview Square	22
12.	North Star Inn	19
13.	Grain Commission	17
14.	Trizec Building	14
15.	Colony Square	9
16.	Library	9
17.	Westin Hotel	9
18.	391 York	6
	TOTAL	591

2.3.2 Commercial Market

Total annual commercial market in the downtown area is estimated at 591 million lbs of steam. The results of the interviews with owners, managers, or maintenance engineers of the larger buildings in downtown Winnipeg are tabulated in Table 2.1. Cooperation was excellent. In almost all cases, we were able to interview people at either the decision-making or recommendation level.

The largest 33 buildings were covered in this survey.

Steam Demand:

The volume of steam listed is an estimate for demand for an average year and, in most cases, is based on actual steam demand or fuel consumption provided by the building owner/operator for 1981. This was increased by 13% to allow for the fact that 1981 was an unusually mild year. Where fuel consumption figures were given, an assumed efficiency of 65% was used to estimate an equivalent demand for steam. In all cases, latent heat of steam was assumed at 1000 Btu/lb., the heating value of natural gas at 1000 Btu/cu.ft.

Price

As a result of our interviews, we were able to determine that all of those users listed in Table 2.1 would join a district heat system at a net saving of 20% of fuel cost or less, in addition to manpower and space savings. This represents a considerable benefit to the users and we feel that a discount in this order would ensure a fairly rapid penetration of the market. Once firm data on steam quality and form of supply contract has been established, it may be possible to obtain a higher price. This should be confirmed in Phase II of the study.

TABLE 2.2

STEAM REQUIREMENTS
INDUSTRIAL & INSTITUTIONAL USERS

		MILLION LBS. STEAM/YEAR
1.	Shell Canada Refinery	1000
2.	Health Sciences Centre	355
3.	Canada Packers	255
4.	Burns Meats	155
5.	St. Boniface Hospital	135
6.	Other Packing Houses	120
7.	Molsons Brewery	35
8.	Building Products	175
	TOTAL	2230

Eatons and Eaton Place, considered together because these users share a steam generating plant, did not give a firm figure for fuel savings required. However, Eatons would save approximately $250,000/year in manpower and Eaton Place would be able to realize the value of the land on which the power plant now stands (perhaps $750,000). We therefore feel that it is reasonable to include these major users in this list.

Reliability:

The question of reliability concerned most users, particularly stability of price. Almost all would require long-term contracts guaranteeing that the price would not rise above a fixed percentage of the most practical alternative fuel.

Market Delineation:

It was found that there was less positive response from the managers of the smaller buildings. Most of these buildings use hot water heat and would incur some expense to connect to steam. For example, personnel interviewed at the Imperial Broadway Tower and the Investors Syndicate Building on Broadway Avenue, both requiring approximately 9 million lbs/year, stated that they would require savings of 50% and 40% respectively.

While there are undoubtedly some who would purchase steam for a net saving of less than $5,000, budget and time constraints precluded any attempt to identify this end of the market which, in our opinion, would add only marginally to the net market penetration by a central steam distribution system. As a result, those buildings identified by computer analysis as requiring less than 9 million pounds of steam were not included in the market study.

2.3.3 Industrial and Institutional Market

Personal interviews were conducted with the Shell Canada Refinery, St. Boniface Hospital, Canada Packers and Burns Meats. Sufficient data was obtained by telephone interview to make personal interviews with other packing houses unnecessary. The annual steam requirements of those surveyed are shown in Table 2.2.

Packing Houses:

Four of the five packing houses interviewed personally or by telephone have stated that they would be interested in purchasing steam at a saving of up to 20% of fuel costs. Canada Packers expressed some reservations, in spite of this representing a saving in the order of $500,000/year (including labour). Of particular concern was the possible loss of production caused by an interruption of steam supply. The local manager of Burns Meats Ltd. stated that they would expect a fuel saving of 33%. However, in our opinion, we are confident that this company would take advantage of the considerable savings obtainable at a 20% saving of fuel costs.

St. Boniface Hospital:

St. Boniface Hospital would benefit from connection to a district heat system in being able to close its present generating facilities, thus effecting considerable savings in manpower costs and avoiding the necessity of spending approximately $900,000 which is planned for replacement of equipment in their boiler house.

The hospital would probably connect to the existing system, at current Winnipeg Hydro prices, if they could be assured of a secure, year-round supply of steam.

Shell Canada:

The Shell Canada refinery is by far the largest user of steam in Winnipeg. With an almost year-round demand for steam, the refinery would add considerably to the economic viability of a district heat system and would justify special arrangements to accommodate the requirements of the refinery. There are, however, two major reasons why this cannot be considered a market for steam:

- Shell requires the supply of steam to be under their direct control. They have to be assured of large quantities of high quality steam to be available at a moment's notice in the event of an emergency, a power failure for example.

- The refinery burns bunker to generate steam. The production of bunker is a necessary part of the refining process but is a product for which there is a limited market.

Shell has stated that they can make 60,000 lbs. of steam per hour available to the central heating system and this might be of interest for peaking purposes.

Health Sciences Centre:

The Health Sciences Centre is at a considerable distance from the expanded distribution system and would be expensive to serve. As a result, this potential customer has not been considered part of the market for this phase of the study. The value of making use of the Health Sciences Centre for peaking purposes may make it economic to include this hospital in the distribution system. This should be investigated in detail in Phase II of the study.

Molson's Brewery:

This brewery could be served economically only if the Health Sciences Centre is included in the distribution system.

Building Products:

Building Products stated that they would be willing to purchase steam at a total saving of 15 to 20% of steam generating costs (including labour) Their labour cost is approximately 15% of the cost of steam. This market could be economically served if an above ground route to the plant on Point Douglas can be found.

2.4 MARKET ANALYSIS

The data obtained from the market research has been used to determine an estimate of the demand on which to base a conceptual design. This data has also been used to identify the market price for steam.

2.4.1 Commercial Market

Table 2.1 shows the commercial market identified in the survey. The market identified represents a demand for steam of approximately 591 million lbs. of steam per year. We have assumed a fairly conservative penetration of this market amounting to 400 million lbs.

In support of this figure, the following points should be noted:

- Public buildings represent a market for 174 million lbs. per year.

- Eatons and Eaton Place represents an almost certain customer, even at zero savings in terms of fuel costs. This represents a market for 119 million lbs. per year.

- The balance of 107 millions lbs. represents approximately 35% of the remainder of the identified market.

- Users representing a total market of 397 million lbs. have either stated, or can be assumed to be, potential customers at an equivalent saving of 15% of fuel costs. (It is assumed that governments and government agencies would purchase steam at 15% savings in terms of fuel costs.)

2.4.2 Industrial & Institutional Market Summary

The Industrial & Institutional Market identified in the market survey represents a total demand of 840 million lbs. of steam per year. This is a fairly firm market, however, we have assumed, for the purpose of this study, that one of the major customers will not be available. We have deleted building Products, at 175 million lbs. per year, since we have not been able to identify a route for a pipeline to this plant in this phase of the study.

The net Industrial & Institutional Market is thus 665 million lbs. per year, at a saving of 20% of fuel. Table 2.3 shows a breakdown of this market.

A more detailed knowledge of the requirements of the Shell refinery may reveal that part of their load could be supplied by a district heat system; this should be investigated in Phase II of the study.

2.4.3 Estimated Market Penetration

The estimated market penetration assumed for the purpose of conceptual design and financial analysis is 1465 million lbs. of steam per year made up as follows:

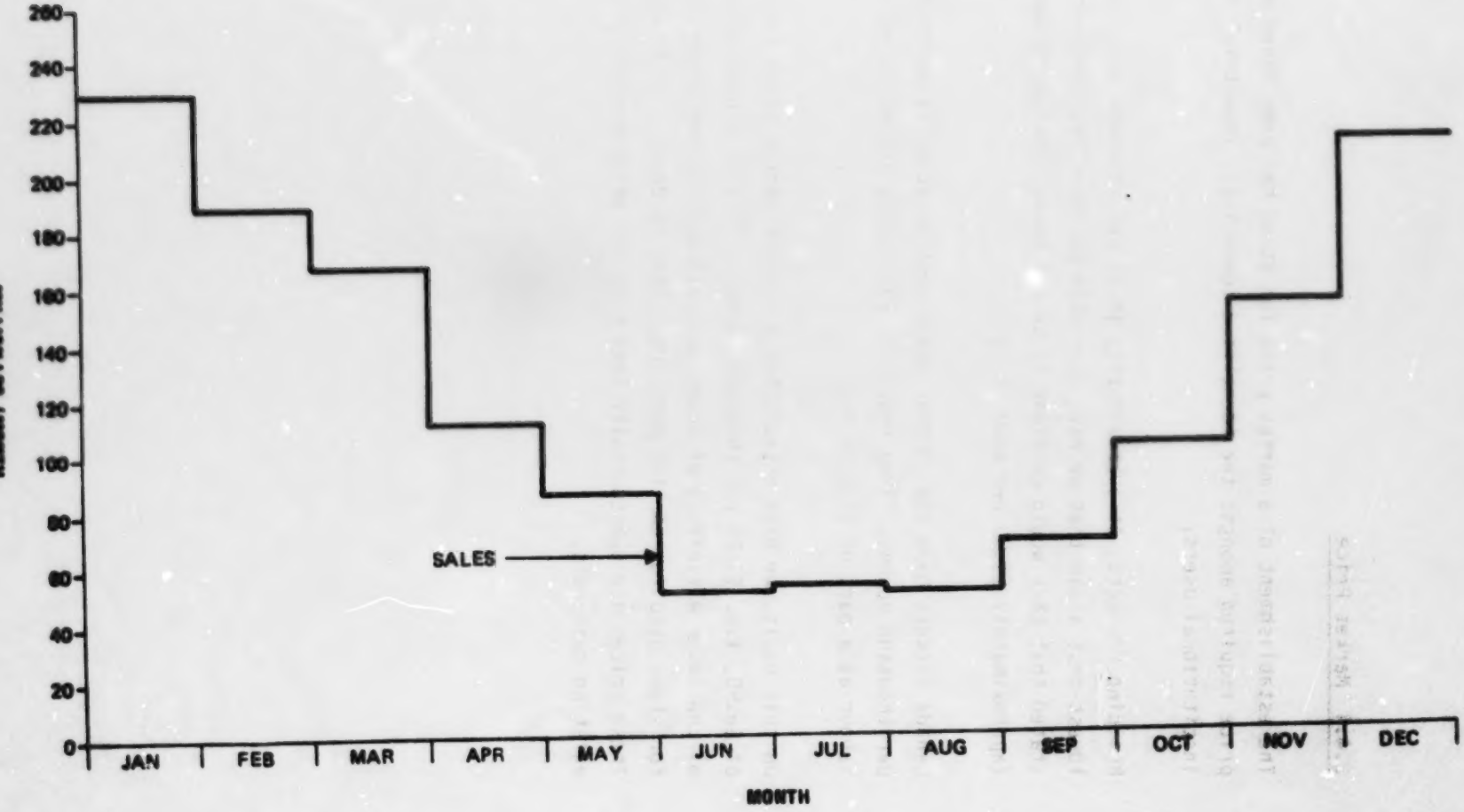
.	existing	400	
.	new commercial	400	(Western Extension)
.	new industrial and institutional	665	(Eastern Extension)
	TOTAL	1,465	million lbs/yr.

A demand profile (Figure 2.2) has been prepared which shows the estimated steam demand on a month by month basis. This has been developed on the assumption that the profile for the additional commercial market will follow the same pattern as the existing demand, and data provided by industrial and institutional users.

TABLE 2.3

STEAM REQUIREMENTS
INDUSTRIAL & INSTITUTIONAL MARKETS

		MILLION LBS. STEAM/YEAR
1.	Canada Packers	255
2.	Burns Meats	155
3.	St. Boniface Hospital	135
4.	Other Packing Houses	120
	TOTAL	665



DEMAND PROFILE

FIG. 2.2

2.4.4 Market Price

The establishment of a market price for steam has been based on the lowest price required amongst the identified commerical, industrial and institutional users.

Building Products, at approximately $6.25 per thousand lbs., have the lowest cost steam that we have been able to identify. However, they have stated that they would consider 15 to 20% saving including labour (approximately $1.00 per 1000 lbs.).

Canada Packers have stated that their cost of steam is approximately $6.50 per thousand pounds. They require a 20% saving and would not consider labour as a part of this saving.

On this basis, we have established a current market price for steam of 80% of $6.50, i.e. $5.20 per thousand pounds. This is a base price. Because of the lower efficiency of steam generation, a higher price can be charged for steam used for heating purposes. This is dealt with in Chapter 4. These prices are substantially less than the price presently charged to the existing customers.

3.0 PLANT AND DISTRIBUTION CONCEPTS

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3.1 INTRODUCTION

In accordance with the Terms of Reference issued by Winnipeg Hydro on May 6, 1982, we have evaluated the various factors and developed a conceptual design for generating plants and distribution systems supplying steam for district heating. The evaluation included a comparison of fuels available, and the scheme proposed for further development utilizes Winnipeg municipal refuse, including commercial and some industrial waste. Four schemes were compared in arriving at the solution proposed. Three of these schemes include the incorporation of the existing Amy St. thermal plant and all include the existing distribution network. Three of the alternatives envisage extension of the network.

3.2 BASIC ASSUMPTIONS AND DATA

3.2.1 Potential Demand For Energy

From preliminary market enquiries, three separate potential heat and/or power demand areas have been identified:

1. The heating demand of the area currently served by the Amy St. Plant and the existing steam distribution network (referred to hereafter in this report as "the existing system").

2. Potential similar additional demands in the adjacent area to the south and west, shown on Figure 2.1. A new system for this area is referred to hereafter in this report as the "western extension".

3. An area in St. Boniface incorporating both heating and industrial process demands. Major steam users and the proposed distribution system are shown on Figure 2.1. This system is referred to as the "eastern extension."

TABLE 3,1

POTENTIAL STEAM DEMAND

	STEAM DEMAND	
	Total Annual $\times 10^6$	Peak Hourly $\times 10^3$
Existing	400	205
Western Extension	400	205
Eastern Extension	665	186
All combined	1,465	596

Data was provided for the existing system but it must be assumed for the western and eastern extensions that potential customers would in fact become participants in future schemes if implemented. Demands, based on past records for the existing and on reasonable assumptions for the east and west extensions are shown on Table No. 3.1. The basis of these assumptions is the Market Survey discussed in Chapter 2.

3.2.2 Refuse Generation: Quantities and Characteristics

One of the primary sources of data on refuse generation was the 1977 report by James F. MacLaren Limited Regional Waste Management Study report. Several other tabulations of data were provided by the Works and Operations Department of the City of Winnipeg. These included:

- 1981 Solid Waste Disposed in Landfills, categorized for each of the three landfills with combustible and non-combustible, and some further breakdown according to source (e.g. Residential, Commercial & Industrial, Land waste, etc.) and according to collection by City Forces and Contract forces respectively.

- 1981 Landfill measured weights for each landfill, categorized according to District of Origin, and City or Contractor for Site 2, and by a coded classification for Sites 4 and 6. The classification indicates the type of waste and in some cases the collector (City or contract).

- Monthly tonnage summaries for Site 2 (1981) and Site 4 (1981 and January - June 1982).

- Comparison of Areas Served: Number of units by type.

  This gives for each district the number of houses, apartments, businesses, etc., served respectively by City and Contract forces.

- Comparison of Areas Served: Units and number of trucks.

- Refuse collection in tonnes by City Forces.

- A graphical presentation of average figures 1978-1981.

Following a meeting and discussion of the figures with Winnipeg Hydro on the 4th August, 1982, we adopted a figure of 415,346 tonnes (456 880 tons) per annum of combustible wastes as a basis, using 4,500 BTU per lb. as the average thermal value.

This provides a very clear-cut basis for conceptual design of energy from refuse plants. Another consideration is the logistics and consequent costs or savings in diverting wastes from landfills to the incineration plant for disposal. Unfortunately, the various tabulations available do not provide a precise basis for determining these costs. This arises because the tabulated information was assembled for other purposes, and came from several different sources without a standardized common basis of measuring and reporting.

For the purposes of the present study, an origin and destination tabulation has been synthesized enabling cost estimates to be made for the various options examined for increases or decreases in haulage costs, and reduction of landill disposal costs. It is considered that the derived cost estimates will be to a degree of accuracy equivalent to that governing the capital and operating cost estimates for the proposed steam plants and systems in this Phase I Study (+20-25%). We understand that the City is presently undertaking an in-house study to accurately define the waste volumes, characteristics, origins and destination. This information will be invaluable in determining hauling and landfill cost savings accurately.

3.2.3 Site Selection

In a very preliminary study of this nature, no final conclusions can be drawn regarding selection of a site for a new refuse-burning steam generating plant. A City-owned site at Mill Street was used in this study to develop preliminary costs. The following factors influence the costs of the facility at this site:

a) The existing Winnipeg Hydro substation should be either relocated, or incorporated into the incinerator plant. Hydro intends to replace this substation by 1989, thus the cost of such replacement has not been included in our estimates.

b) Better access must be provided for refuse trucks and costs for such improvements have been included.

c) The site could be affected by future river bank developments. This factor has not been taken into consideration in this analysis.

Detailed investigations, followed by approvals by planning and environemtnal authorities, will be required for selecting a site during the second stage of the study. The following criteria are considered important for such selection:

1. Proximity to potential demand areas.
2. Proximity to existing steam plant.
3. City rather than private ownership.
4. Existing and projected land use.
5. Accessibility by road and rail, if possible.
6. Proximity to and central location in refuse generation area, if possible.
7. Availability of utilities.

TABLE 3.2

WINNIPEG HYDRO
STEAM PLANT CAPACITY - AMY STREET PLANT

BOILER NO.	CAPACITY	PRESSURE	TEMPERATURE
1	70,000 lb/hr	225 psig	550°F
2	70,000 lb/hr	225 psig	550°F
3	70,000 lb/hr	225 psig	550°F
4	70,000 lb/hr	225 psig	550°F
5	125,000 lb/hr	225 psig	600°F
6	125,000 lb/hr	225 psig	600°F

Notes:

All of Boilers No. 1 to 6 may be used to operate Turbine Generators No. 1 (4 MW) and No. 2 (5 MW).

7	164,000 lb/hr	415 psig	750°F
8	280,000 lb/hr	415 psig	750°F

Boilers No. 7 and 8 are generating boilers that operate Turbine Generator No. 3 (15 MW) and No. 4 (25 MW). They can also be used for heating through a heat exchanger with a capacity of 125,000 lb/hr. Boilers 7 and 8 have closed steam systems.

ELECTRIC BOILERS

1	27,000 lb/hr	225 psig
2	27,000 lb/hr	225 psig
3	27,000 lb/hr	225 psig

DISTRIBUTION SYSTEM SUPPLY

Steam to mains goes at 70 psig and 350°F down to 30 psi in spring.

Maximum flow to mains is 270,000 lb/hr plus approximately 10 percent for plant services or 297,000 lb/hr.

3.2.4 Existing Steam Plant and Distribution

Regarding the Amy St. Plant, Winnipeg Hydro provided copies of:

1. Report on Manitoba Government Buildings heated by Winnipeg Steam Plant (Reid, Crowther & Partners Ltd., 1974).

2. An Engineering Economic Investigation into the future of the Central Heat Distribution System by Winnipeg Hydro, 1982.

3. A descriptive report "Amy St. Steam Plant and Terminal Station".

4. Statements under the Clean Environment Act, "Winnipeg Hydro Amy St. Plant", Volumes I and II, (1980) by Winnipeg Hydro.

5. Brown Boveri Technical Specifications for the 25 MW and 15 MW Turbines, Amy St. Plant.

6. Operating Data Sheets for Boilers, Nos. 7 and 8, Amy St. Plant.

These reports and documents give a very complete description of the existing equipment, the costs and economics of operation and the modification necessary for the plant to meet the requirements of the Clean Environment Act.

For reference, a listing of the main steam and electrical generating units is given at Table 3-2. The conditions and characteristics directly affecting the present study are:

1. Requirement to add electrostatic precipitators (if present fuel use continued) in order to meet Clean Environment Act standards.

2. Capacity to meet various conditions when used as a peaking plant.

3. Availability of turbine generators, and their capability of modification for use in parallel or cogeneration alternatives.

4. Obligation to provide electrical power when called upon by Manitoba Hydro.

5. Present and future fuel use. Boilers No. 1, 2, 3 and 4 using bituminous coal, Nos. 5, 6, 7 and 8 using lignite, plus 3 Electric boilers. Replacement and/or modification require detailed investigation, beyond the scope of the present study, as determined by considerations of:

   - total and peak steam outputs required
   - environmental constraints
   - condition of existing equipment
   - fuel selection, depending in turn on

     . present and future cost projections
     . rate schedules
     . environmental impacts
     . availability
     . transportation, processing, storing and handling
     . costs of replacements and modifications.

The distribution system is reported to require substantial replacement over the next few years. The cost of this is included in the Amy Street upgrading costs.

3.3 TECHNOLOGY OPTIONS

3.3.1 Fuels

Based on a technical and economic analysis, municipal refuse is considered as the primary fuel for the proposed district heating system. Coal is proposed as the winter peaking fuel, and natural gas as start-up and back-up fuel at the incinerator plant.

An economic evaluation of the various fuels is presented in Chapter 4. Technical characteristics of refuse and other fuels are discussed.

Refuse

The use of refuse as a fuel for City district heating systems has several advantages:

- It can replace alternative non-renewable fuels.
- It achieves the dual objective of producing heating and substantially reducing an otherwise difficult and costly problem of disposal.
- It is a comparatively clean-burning low-sulphur fuel.

In producing 1465 million lbs/year of useful steam for the Winnipeg situation, the use of refuse fuel replaces the equivalent of 250,000 barrels of oil per annun. Drawbacks to its use as a fuel are:

- Imbalance of supply and demand. There is an insufficient supply to meet winter peak requirements and a vast over-supply in summer.
- There are limitations to the capability of storage, because of its putrescible nature and low density.
- It is less convenient than other fuels such as gas, oil or pulverized coal to feed to combustion.

For mass burning, a value of 4500 Btu/lb has been assumed for the study. An important consideration is the monthly variation in both quantity and thermal value. From records of incineration plants in Montreal, Quebec and Chicago, and others analyzed by SNC, it is found that the specific steam rate (pounds of steam per pound of solid waste) varies around the median value in a sinusoidal curve because of the combined effect of changing composition and changing thermal value month by month. The thermal value is actually less in the summer months, when the quantity is high, and vice versa. Thus, the potential total thermal value remains much more constant than might be expected judged on quantity alone at an assumed average or constant BTU/lb.

The main impact for the situation under review is that the summer peak steam quantity will not be much in excess of the average, even though waste handling and throughput have to be designed and operated for a summer peak condition.

As the sale of steam is a major revenue for the Energy from Waste plant, an increase in the heating value reduces the operating costs. Second, it governs the mass throughput of the incinerator unit, since the boiler is designed for a maximum heat release rate which should not be exceeded, at least theoretically. An increase in the heating value thus requires an appropriate reduction in the solid waste throughput, or simply expressed, it causes derating. This means that somewhat more boiler capacity is required to incinerate the same amount of solid waste with higher heating value. This may mean running more units at partial load instead of fewer units at maximum load or even overload. The choice is an operational one.

Only in the event of reaching the full capacity of the plant does this problem become an economic one. The choice then consists of either routing excess waste to the dumpsite which is equivalent to losing revenues from the tipping fee, or to install a new unit for processing the excess waste. Many European plants faced this decision in the past, largely due to the phenomenal increase in the heating value and most plants decided to install additional capacity as the additional revenue from steam sales and from tipping fees justified the plant extension.

In the Winnipeg situation, there is in fact insufficient refuse fuel available to meet peak requirements, even though total annual demand could be met. In these circumstances the additional available steam sales must come from burning other fuels, which can be achieved by utilizing the capacity at the Amy St. Plant.

In projecting future availability of waste and its fuel value, three factors are significant:

- population growth
- changes in waste generation per capita
- changes in thermal value of waste

Recent studies have shown that increases in per capita generation are slowing down, and that although thermal content per unit weight will probably continue to increase, this may be only of the order of 4.5% in 10 years.

It is considered that for the purposes of the present study, a conservative assumption should be made regarding projection of refuse quantities and thermal content, and no growth assumed.

Other Fuels

Alternative fuels require evaluation both for the Mill Street incineration plant, as start-up and back-up fuels, and also for use in the Amy Street Plant, which is required to carry the winter loads which exceed the capacity of the Incineration plant.

The primary criterion must be the consumption and depletion of non-renewable resources, and in this regard the only potential fuel which could be classified as renewable would be biomass and wood wastes. The other criteria for comparison of fuels include:

- availability
- overall cost, including transportation, handling, storage and processing
- future price trend
- environmental impacts of use and consumption
- technology of combustion.

In this initial Phase I review of alternatives, the less conventional fuels such as biomass and peat are discarded. Biomass is not considered to be economically available in the Winnipeg area. Peat is not currently produced in North America on a commercial basis, and it is not therefore practical at the present time to derive applicable costs. While North American boiler manufacturers state that peat could be burned in their units, none has actually constructed a unit designed to fire peat solely or in combination with refuse.

Considered as available potential fuels for the purpose of this Report are bituminous coal, lignite, oil (No. 2 or No 6) and natural gas. Coal and oil characteristics are summarized below:

	Saskatchewan lignite	Alberta bituminous	No. 2 Oil	No. 6 Oil
Heating Value (HHV) Btu/lb.	6950	11,505	19,486	17,987
Sulphur %	1	1	0.5 - 1	2.5
Ash %	9.75	10	-	-

In view of the projected prices and the fact that Amy Street is presently burning coal, coal/lignite are selected as the winter peaking fuels.

This evaluation indicated that for a major new plant refuse burning could be the basis of an economically viable system, while coal or other fuels could not. The comparisons which follow are confined to technical characteristics.

Characteristics of the various fuels follow:

Coal:

- requires an extensive long-term storage area required
- requires conveying, daily storage and feed facilities required
- potential dusting problem for storage
- particulate emission problems from combustion
- cannot normally be burned on grates designed for mass-burning of refuse.

Lignite: generally as for coal except:

- pulverization for feed to existing Amy Street Boilers No. 7 and No. 8 required
- lower emission problem than bituminous coal

Oil (No. 2 or No. 6):

- site storage required
- feed arrangements to units relatively simple
- sensitive heat input variation response
- long-term future availability uncertain

Natural gas:

- clean fuel with relatively minor emission problem
- no storage requirements
- feed arrangement to combustion units simple
- sensitive heat input variation response
- may only be available on an interruptible basis

As related to the proposed new incineration plant, either oil or gas is suitable for use for start-up and as back-up fuel. From technical considerations and from the long-term uncertainties regarding oil, natural gas is the preferred alternative.

3.3.2 Incineration Technology

Energy-from-waste technology has been under vigorous development in several different directions during the past fifteen years. In addition to the refinement of mass-burning in water-wall incinerators, which has been successfully used in Europe for over thirty years, research and development has been pursued in several newer technologies.

Several of these were listed and described in the MacLaren Report of 1977. Subsequent experience has seen the start-up of some new facilities in both the United States and Europe including a new semi-suspension fired plant at Niagara, U.S.A. However, this has not produced any new reliable indication that newer technologies will become more economical or satisfactory than mass-burning.

Of the two most satisfactory systems, mass-burning and suspension firing, there is a considerably more extensive history of satisfactory experience with mass-burning than with semi-suspension firing. However, several factors merit some evaluation and comparison.

Semi-Suspension Firing

While there is much less operational experience from major installations to draw on as compared with mass-burning, semi-suspension firing is now considered an established and reliable method.

The quality of the refuse derived fuel (RDF) can be improved by additional processing. Even a minimum processing fuel product, with coarse shredding to a 100 mm (4 inch) size, provides a material which is more uniform and with lower moisture content than raw refuse.

Some of the factors to be considered when comparing with mass-burning are listed below:

- requirement for capital-intensive front-end processing of wastes;
- higher thermal efficiency:
- continuous feed;
- more homogeneous fuel thus fewer "hot-spots";
- better surface area contact with combustion air;
- avoidance of thick layer on stoker grate;
- lower combustion air requirements - improved and lower cost emission control;
- corrosion incidence has been low in existing installations, although world-wide experience is still limited in this regard;
- coal can be used as back-up or supplementary fuel;
- RDF and back-up fuels can be burnt simultaneously;
- more complete burnout of residues. Depending on front-end processing, these may be more conveniently handled than mass-burning residues.

Mass-Burning Incineration

This method has been thoroughly proven in many installations around the world. From this experience sophisticated designs have evolved enabling an adequate degree of combustion control to be attained as well as efficient recovery and utilization of the heat energy. There are a number of manufacturers of reliable units. The configuration and design parameters used vary between suppliers. However, the following advantages and disadvantages are applicable to mass-burning systems in general:

- can handle virtually all materials with a minimum of pre-processing;
- can be fed relatively continuously;
- can be adapted to daily changes in volume or waste content;
- thick burning bed limits combustion air contact;
- local slugs of materials can create hot-spots, and changes in combustion gas content;
- comparatively complete burnout, but residues are abrasive and some organics remain;
- overfire and underfire air: quantities relatively high requiring higher capacity emission clean-up processes.

The adoption of sophisticated front-end processing is justifiable when carried out for the dual objectives of separating components for sale and improving both thermal content and physical characteristics for suspension firing. Some unit processes may also be included to remove materials which cause excessive wear in subsequent process equipment. Such processing involves substantial capital cost, and additional operating costs in personnel, power consumption and the maintenance of equipment subject to extremely severe operating conditions. Its justification on economic grounds depends heavily on there being good and stable markets for the secondary recovered materials. Such markets are subject to wide price fluctuations. In times such as the present when even materials from conventional sources are not in demand, there is no market for recovered material whose quality may be questionable.

From previous evaluations of the cost and profitability of separating materials for re-sale (MacLaren Report for Winnipeg, and by SNC for Niagara Region, Hamilton County - Tennessee, and others) it is not considered appropriate for the proposed new facility. When the longer and better demonstrated experience history of energy-from-mass- burning is also taken into account, we conclude and recommend that mass-burning technology be adopted.

3.3.3 Power Generation

The generation of electrical power in conjunction with the generation of steam for space heating or industrial processing can be considered in two modes:

- parallel generation, in which available steam can be directed, to the extent required, to the steam distribution system. To the extent it is not required for heating, steam is directed to turbines for electric power generation.

- cogeneration, in which all steam is passed through a back-pressure turbine, generating electrical power, with the exhaust steam then being used for space heating and/or industrial process use.

In the existing plant at Amy St. two boilers supply the power generation turbines, the remainder supplying the district heating system, each system normally operating as a single purpose one. However, as indicated in Table 3-2, Boilers Nos. 7 and 8 can provide steam for heating through a heat exchanger.

Where a new steam generation plant is under consideration as at present, the possibility of parallel or cogeneration using either the existing turbines or new turbines or both can be considered. The principal consideration is one of overall system economics, in which one of the additional costs will be the requirement for generation of steam at higher pressure and temperature than would be required to meet district heating duties alone. Also, in a system whose capacity is fixed at a level

determined by the foreseeable peak demands for heating, the availability of steam for power generation is determined by the annual cycle of temperature variation. In Winnipeg conditions, the period available for maximum electrical output is quite short so that the utilization factor is correspondingly low.

Since the refuse must be disposed of year round regardless of weather and temperature, power generation, if economic, provides a base load when steam for heating is not required.

The possibilities have been evaluated in conjunction with the various alternative systems, as discussed in the section on Implementation Options.

3.3.4. Transfer Media

The existing district heating system utilizes steam from the Amy St. Plant at a nominal 70 psig pressure and 350^{o} temperature. Since the Amy St. Plant is required to be retained in 3 of the 4 alternatives considered, and the existing distribution system also retained, the use of steam as a heating medium rather than hot water has been assumed.

In further support of this approach, it is noted from the Market Survey that only a small number of consumers on the western extension and none on the eastern extension utilize hot water heating.

For steam users conversion to a hot water supply would be more costly than the corresponding adaptation from steam to hot water in the case of hot water users.

TABLE 3.3

IMPLEMENTATION OPTIONS

	AREA[1] SERVED	STEAM DEMAND (LBS) Annual Total x 10^6	STEAM DEMAND (LBS) Peak Hourly x 10^3	FUEL[2] REQUIREMENT AS REFUSE TPD TO MEET PEAK	INCINERATION[3] CAPACITY TPD	NO. & SIZE OF UNITS	FROM[4] ANY ST. OR OTHER PLANTS LBS/HR x 10^3
Alternative 1	Existing	400	205	781	1700[5]	4 x 425	-
Alternative 2	Existing + Western	800	410	(1562) 1250	1275	3 x 425	147.5
Alternative 3	Existing + Eastern	1065	391	(1490) 1250	1275	3 x 425	128.5
Alternative 4	Existing + Western + Eastern	1465	596	(2270) 1250	1275	3 x 425	333.5

NOTES:

1. There is no case for Western or Eastern alone without existing.
2. Actual requirement in parentheses. Maximum available 1250 TPD.
3. 20% in-plant steam usage provided for in new incinerator plant.
4. Net requirement to consumers.
5. High capacity required to provide standby for breakdown during peak demand periods.

3.4 IMPLEMENTATION OPTIONS

Four alternatives have been evaluated and compared, based on the use of refuse as the primary fuel for new steam generation plant, and taking into account the existing plant at Amy St. and its capability of upgrading to become part of a new extended system, or alternatively, to be replaced by a new plant. These are presented in Table 3.3. Capital Costs for each case are summarized in Table 3.4.

From the Table 3.3 it is immediately apparent that the refuse fuel available is barely sufficient to generate the steam demand in the area already serviced. Thus any extension into other areas is contingent on upgrading the Amy St. Plant and retaining it in service.

The four alternatives discussed are as follows:

- Alternative 1. Existing system. New refuse-fired plant replaces Amy St. to serve existing system.
- Alternative 2. Existing plus Western extension. New refuse plant, using Amy St. as peaking plant.
- Alternative 3. Existing plus Eastern extension. New refuse plant, using Amy St. as peaking plant.
- Alternative 4. Existing plus Eastern plus Western extension, using Amy St. as peaking plant.

In all alternatives it is assumed for Phase I of the study that, as at present, condensate is not returned. If a scheme showing good potential is pursued to a further stage of investigation and/or implementation, the question of condensate return should be investigated in detail as part of the process of optimising the system.

TABLE 3.4

COMPARISON OF ALTERNATIVE SCHEMES

CAPITAL COSTS - $ x 10^6

	Alt. 1 Modified Existing System	Alt. 2 Existing Plus Western	Alt. 3 Existing Plus Eastern	Alt. 4 Combined System
Incineration plant and ancillaries	95.5	73.5	73.5	73.5
Pipe network	0.3	3.55	3.45	6.7
Conversions	-	0.6	-	0.6
Upgrade Amy Street Plant	9.00	19.81	19.81	19.81
Cost of closing existing system	5.4	-	-	-
	110.2	97.46	96.76	100.61
Steam Sold (lbs. x 10^6 per annum	400	800	1065	1465
Capital cost/1000 lbs.	$275.50	$121.83	$ 90.85	$ 68.68
Annual operating costs $ x 10^6	4.5	6.31	6.31	6.75
Operating cost/1000 lbs.	$ 11.25	7.89	5.92	4.61

NOTE: These are not NET operating costs.

Tipping fees and other benefits are excluded. See Chapter 4.

3.4.1 Alternative 1 - Existing System

Total demand - 400×10^6 lbs/yr
Peak demand - 205×10^3 lbs/hr
Minimum summertime demand - Nil

Requirement for refuse fuel based on peak demand: 781 TPD (tons per day)
Refuse available: 1250 TPD.

The objective of this alternative is to eliminate the Amy St. plant, which would then be unavailable for a "peaking" function. Thus to make a new refuse-burning station sufficiently reliable to meet peak loads, it should have an entire incinerator/boiler module available as stand-by in case of outages, or instead of 3 No. 425 TPD modules, four would be required. This required a large capital outlay for redundant equipment, as well as substantial increase in space availability.

As seen from the capital cost comparison (Table 3.4), this alternative is much less economic than the others in capital cost per 1000 lbs of useful steam generated.

A further major drawback is one suffered by the present system, low utilization because of a zero summertime demand. This drawback is more serious in the case of a refuse-burning plant, since the refuse must either be diverted elsewhere, or the steam generated in summer must all be condensed. Although absorption air conditioning could conceivably provide an alternative summer load, it is unlikely that sufficient application could be found in the area concerned. While the basic concept of this alternative is the elimination of the Amy St. Plant, power generation would involve the use of the 15 MV turbine. However, as discussed in a subsequent section this appears to be a marginal benefit.

The distribution system modifications under this Alternative involve only a main from the new plant to feed to the existing system near Amy St. The existing network, as noted previously, requires substantial replacement over the next few years.

3.4.2 Alternative 2 - Existing Plus Western Extension

Total Demand	800 x 10^6 lbs/yr
Peak Demand	410 x 10^3 lbs/hr
Minimum Summertime Demand	Nil

Requirement for refuse fuel, based on peak demand - maximum available.

As discussed in a previous Section, the actual availability of refuse varies from the average by plus or minus two percent, which when combined with thermal value which also varies (though not in parallel with quantity variation,) there could be a deficiency up to 2% during February, one of the most critical months. A short-term deficit could be made up by the burning of supplementary fuel, but the operation is marginal.

In this alternative, a refuse-fired steam plant would supply steam to the maximum available thermal capability and be supplemented to make up the difference on peak days by the Amy St. boilers to reduce the built-in stand-by capacity necessary in Alternative 1. A 1275 TPD plant consisting of 3 x 425 TPD modules would be installed.

This capital cost reduction and the supply of double the quantity of steam make this alternative more attractive than No. 1 in terms of capital cost per 1000 lbs. of useful steam. However, both the new plant and the Amy Street Plant operate at a low effective annual utilization because of the seasonal load fluctuation, which drops to zero for the 3 summer months.

Alternative 2 calls for the construction of a new steam distribution system for the Western area. The existing and new systems require interconnection for the Amy Street Plant to meet peak requirements beyond the capacity of the new refuse-fired plant.

3.4.3 Alternative 3 - Existing Plus Eastern Extension

Total demand	1065×10^6 lbs/yr
Peak demand	391×10^3 lbs/hr
Minimum summertime demand	96×10^3 lbs/hr

In the eastern extension, a number of industrial process customers could be served, providing a year-round base load. This substantially improves utilization, and consequently overall system economics.

Again, a maximum-sized refuse-fired plant would be required, which would require back-up as before by the Amy Street Plant to meet winter season demands.

Apart from the improved utilization factor, the system is similar to Alternative 2. A further advantage, however, is that much of the steam supply main could be built above-ground alongside railway or Hydro right-of-way, rather than under City streets.

3.4.4 Alternative 4 - Existing Plus Eastern Plus Western Extension

Total demand	1465×10^6 lbs/yr
Peak demand	596×10^3 lbs/hr
Minimum summertime demand	96×10^3 lbs/hr

This alternative combines the advantages of Alternative 3 with a still greater production of useful steam, the only additional capital cost being for the distribution system for the Western area. The advantages offset a utilization factor slightly lower than that offered by Alternative 3.

3.4.5 Electricity Generation

In conjunction with Alternative 1, a system of parallel generation was developed.

As the condensate is not returned from the district heating system, 100% make-up water is required. The heating of this water to 287°F temperature consumes a little more than 20% of the steam produced in the winter.

As the live steam pressure and temperature are too high, a pressure reducing and desuperheating station is required. The feedwater used for desuperheating increases the amount of steam required.

The existing 15 MW turboset would return its condensate at 285°F to the incinerator plant.

The evaluation of the annual power generation is as follows:

The minimum amount required for ancillary purposes equals approximately one-third of the 205,000 lb/hr peak demand and, therefore, it corresponds to the average demand over the year. Using degree-day data and an annual load duration curve, it can be shown that the condensing turbine can operate over 5500 hours in a year at full output and over 3000 hours at varying output, averaging about half capacity, or 7.5 MW.

The annual electricity produced is therefore:

$$15 \times 5500 + 7.5 \times 3000 = 105{,}000 \text{ MWh}$$

The incremental cost of the high pressure/temperature incinerator boiler plant against a low pressure plant (say 125 psig, 305°F) is estimated at about $6 million including all items affected by the higher steam conditions and assuming that the plant would have 3 x 425 t/d units installed. In addition, a steam and feedwater interconnection would be required between the incinerator plant and the Amy Street Plant, the cost of which is estimated at $800,000. The total incremental cost is therefore

$6.8 million. From this, the cost of a steam condenser should be deducted, as this would be required if the incinerator plant were not interconnected with Amy Street which makes the net incremental cost to be about $6.3 million.

In conjunction with Alternative 4, a cogeneration system was developed. The backpressure turbine exhausts to the existing district heating network and to the Western extension. The backpressure can be adjusted (manually) between 70 and 40 psig, depending on the steam flow rate, so as to maximize power output. Exhaust steam is also used for preheating the 100% make-up water for the entire plant, which requires about 20% of the steam produced. The Amy Street Plant provides the balance of steam for the district heating networks and prepares its own make-up water.

In the summer, when the steam generation exceeds the steam demand of the Eastern extension plus the in-plant use of steam for feedwater heating, then the surplus steam will have to be condensed either in the new incinerator plant or could be piped over to Amy Street, as turbine exhaust steam. The backpressure turbine could, therefore, operate all year round.

Considering variable backpressure operation, the output of the turbo-generator varies between 6400 kW and 5100 kW electricity. Taking 5200 kW as the average output and 8000 hours operation in a year, a total of 41600 MWh of electricity would be generated.

The installed cost of the turbogenerator is estimated at $2.6 million. The incremental cost of the 1275 t/d incinerator plant on account of the 750°F superheat temperature is about $1.0 million.

A third possibility combining these two approaches may be possible, but full investigation of this alternative would require a better knowledge of the industrial steam demand profile throughout the year and the flow diagram and performance data of the 15 MW turbogenerator. The incremental cost attributable to power generation should be no more than that indicated

for Alternative #4, but the amount of power generated would increase substantially, so that the economics of this scheme could be quite attractive.

The price at which the electrical power supplied would be acceptable at present does not appear to justify the capital costs. However, the possibility should be re-examined as a possible beneficial optimization if final design and implementation proceed.

3.4.6 Recommended Alternative

Comparison of the capital and operating costs per 1000 lbs of useful steam produced shows Alternative No. 4 to be the most economic of the schemes, and it is therefore proposed as the basis of conceptual design. This alternative is the one recommended, and the one referred to in the subsequent sections of this chapter. See comparison in Table 3-4.

It should be noted, however, that the scheme developed here is basic only. If it appears attractive enough to warrant further investigation and/or implementation, several aspects could be examined in greater depth and optimized, probably resulting in an even greater economic advantage. Features offering such possibilities include:

- Possible additional steam demands beyond the limits considered in this Report.
- Re-examination of cogeneration.
- Condensate return vs. cost of water pumping and treatment.
- Pipe sizing on actual distribution system adopted.
- Possible use of other existing steam generating plants on or near the proposed system as peaking plants.
- Use of alternative back-up fuels.

3.5 CONCEPTUAL DESIGN FEATURES

3.5.1 System Characteristics

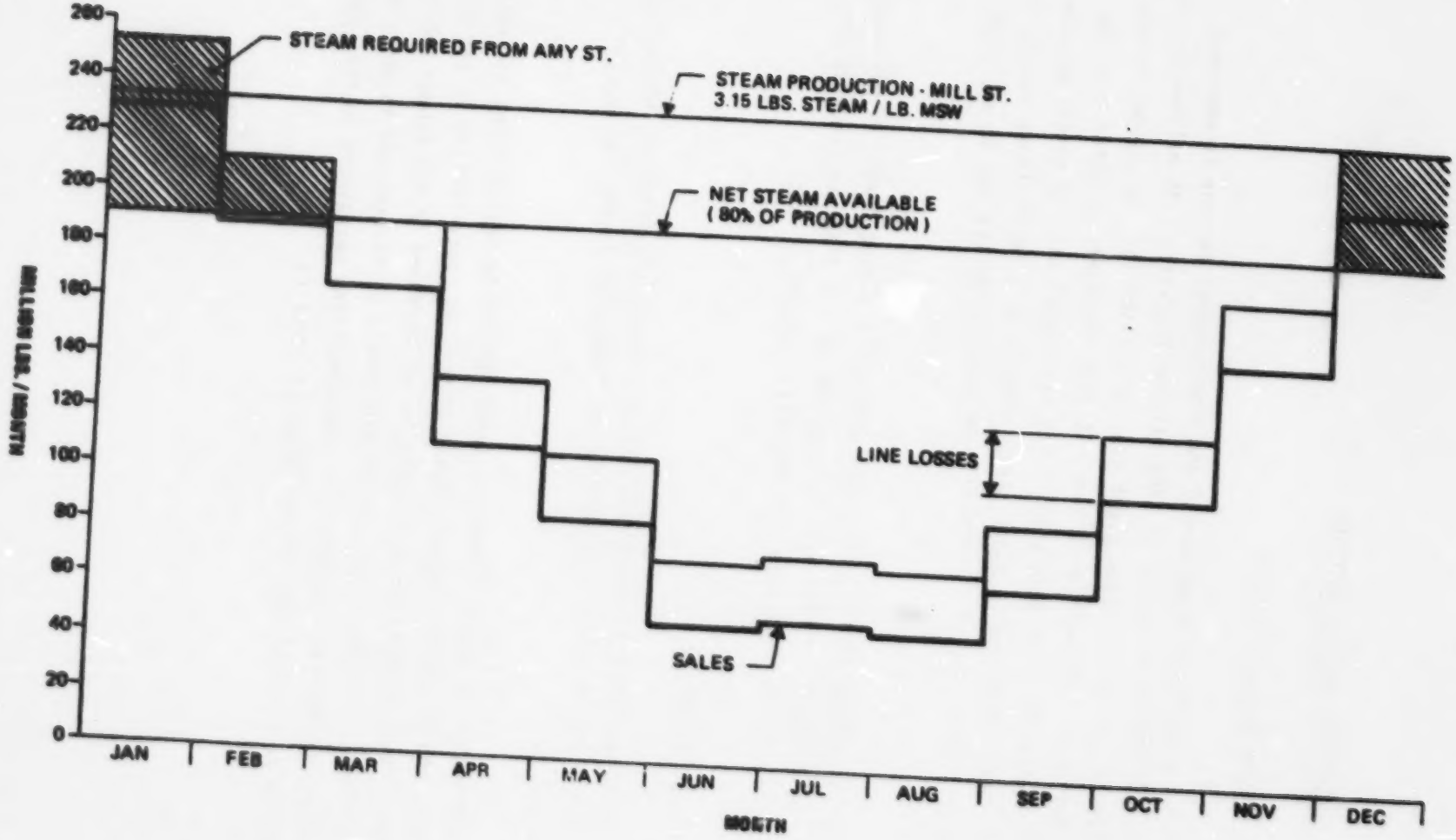
Figure 3.1 presents a steam demand and supply curve for the recommended system. Of the total market of 1465 million lbs/year, 1345 million lbs is supplied by the incineration plant and 120 million lbs. by the Amy Street plant during winter peaking season. It must, however, be noted that the actual amount of steam generated at the two plants will be higher because of the line losses and in-plant steam production. Taking these losses into account, 15,645 tons of lignite will be consumed at the Amy Street plant annually.

During the summer months, available steam will exceed demand by 665 million lbs. Although facilities will be provided at the plant to condense this steam, it will be available for potential industrial usage.

3.5.2 Areas Served

The proposed district heating system will serve the existing, western and eastern areas as previously defined in "Potential Demand for Energy" Section 3.2.1.

The system will supply steam for space heating in the existing and western areas, and industrial process steam as well as space heating in the eastern area. Power generation and supply is not proposed in the scheme herein described. However, this possibility should be re-examined in any final design, to determine whether, in the conditions pertaining to the system selected, it might add further marginal benefits.



SYSTEM CURVE

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FIG. 3.1

3.5.3 Steam Generating Plants

The proposed scheme will retain the existing Amy Street Plant as a peaking plant. Certain modifications previously identified (addition of electrostatic precipitators and boiler replacements) will be required. Upon more detailed examination of the plant, other modifications may also prove desirable.

A new refuse-burning energy-recovery incinerator is required and it is assumed to be constructed at the Mill Street site. It will consist of three No. 425 ton-per-day incinerator/boiler units with all necessary ancillaries. The units will be mass-burning, water-wall type. Typical sections and site layout are shown in Appendix C. Each unit is capable of producing 110,250 lbs/hr gross at 125 psig and 405°F. It should be noted, however, that daily production is limited by fuel availability. Using a conservative system efficiency of 70%, this would be equivalent to 328,125 lbs/hr of steam with all 3 units operating.

3.5.4 Distribution Network

Steam mains joining the new Mill Street Plant with Amy Street Plant can be placed above ground following the rail tracks and riverbank. The main supplying the eastern network in St. Boniface can also follow the rail tracks above ground for a substantial portion of its route. The western extensions, however, must necessarily be located below grade along City streets. No allowance has been made for possible redevelopment of the riverbank.

Piping costs provide for expansion loops, anchors, supports, guides and insulation as required.

3.5.5 Refuse Supply System

All available combustible refuse will be diverted to the new plant at Mill Street. Considerable quantities of waste presently going to landfill are not classed as combustible. 220,000 tons per annum (approximately) will still require to be disposed of, presumably in one or other of the existing landfills. Further, the incineration residues will amount to approximately 20% by weight of the raw waste incinerated. 91,300 tons per annum of these residues will require disposal. It has been assumed for the calculation of operating costs for this Report that such wastes would be hauled to the No. 6 site for landfill. Provision will be made in the design of the facility for storage of 4 days' refuse in the receiving pit, to allow for the operation of the boilers during the long holiday weekends.

3.5.6 Excess Steam

During the summer months, steam will be generated by the new refuse incineration plant in excess of requirements for process and other use. Provision will be made for condensing the excess at the new plant.

3.5.7 Reliability

While the new Mill Street incinerator plant would supply the total annual steam demand if evenly distributed throughout the year, the seasonal variation causes excessive daily production in the summer months. Peak hourly rates in winter, however, vastly exceed the capability of the plant to produce steam. Combined with the Amy Street capacity, demands can be met for all but a few of the coldest days each year.

Annual and peak demands are tabulated in Table 3-3. Hourly maximum supply capability without calling upon Boilers Nos. 1, 2, 3 and 4 at Amy Street are:

Incinerator	328,125*lbs/hr
Amy Street	456,000 lbs/hr
	784,125 lbs/hr

*Based on average hourly refuse availability.

To ensure reliability of service to consumers, it is necessary to consider the possibility of a major unit at Amy Street or at the new incinerator being unavailable for service, at the peak period, due to repairs or major maintenance. Thus, the gross combined production must be reduced by 125,000 lbs/hr for this contingency in the case of Amy Street. At the incinerator plant, 2 units could produce 220,500 lbs/hr or 107,625 lbs/hr reduction with the third unit down. The worse case is the outage of one unit at Amy Street, leaving a combined gross production of 659,125 lbs/hr.

For a limited period (say 2 days approximately), the incinerator plant could provide 330 750 lbs/hr, increasing the gross production to 661,750.

In-plant usage and system losses further reduce the net steam available to the user. Past experience indicates a 12.75% loss at peak output in the Amy Street system in the worst case in recent years. Allowing a 20% loss for the incinerator plant, the production rate (net to consumer) must be reduced to:

Amy Street	288,800 lbs/hr (one boiler out)
Incinerator	262,500 (based on average hourly available fuel)
	551,300 lbs/hr

Thus, in these conditions, there is a deficiency of 44,700 lbs/hr to be met. This peaking requirement could be taken care of either by utilizing the capacity of Boilers 1 - 4 at Amy Street or by other steam generating plants on the network to be supplied.

Since the incidence of this requirement is of relatively low probability, and its duration short if it does in fact arise, it is recommended that final selection in this regard be deferred to the Phase II study or the system implementation. Capital cost provision has been made for upgrading the Amy Street Plant.

Apart from major units, ample stand-by capacity in ancillary equipment is available for peak production periods.

Another factor is reliability in the supply of refuse fuel to the new plant. Design, as mentioned, will provide for refuse storage so that fuel can be available even following long weekend holiday interruptions of collection. In addition, a supplementary fuel (oil or natural gas) will be available mainly for start-up purposes. This can also be used to supplement the refuse in generating steam. The incinerator unit's basic design is for refuse burning, rather than other fuels, but with some sacrifice in efficiency of burning other fuels, they can be used for short periods as back-up.

The incinerator unit configuration (425 x 3 TPD) is selected to provide some flexibilty in removal of a unit from service for major maintenance. However, all three units are required for burning the normal daily output of waste. The nominal overcapacity is only 2%. Thus for periods when one unit is out of service, 400 TPD of waste must be diverted to landfill once the small storage reserve has been used up. This expedient, however, is considered more economical than providing an incinerator/boiler unit. With unit utilization at 85%, the need for diversion of waste to landfill should not exceed 20 days per year.

3.5.8 Materials Recovery

As indicated earlier, the recovery of materials is a case of marginal economics.

Materials recovery is secondary to the objective of economic district heating and should be considered separately as a possible adjunct at a later stage. No provision has been made in the capital cost estimates for material recovery processing. Provision has been made however, for shears at the receiving floor so that objects too large for the feed chutes and mechanism can be dealt with.

3.5.9 Hazardous Wastes

While certain types of hazardous wastes are disposed of by incineration, the mass-burning type of refuse incinerator is not designed for the high-temperature operation often required for special wastes. There is some advantage to disposal by incineration rather than landfill for certain components such as pathological wastes, but it is necessary to take precautions to prevent explosive materials from being fed to the incinerator.

3.5.10 Staff Requirements

Requirements for the new incineration plant, if considered in isolation, would be 42 operating personnel to include:

Administration and clerical	5
Maintenance	18
Operations	19
	42

If located at the Mill Street, coordination of the two operations could effect some reduction of this additional requirement, in both the administration and maintenance categories, reducing the addtiional personnel by 3 administrative and 9 maintenance personnel to 30 total. This would necessitate centralizing or combining much of the record keeping for the two plants, and having some of the maintenance technicians such as electricians, instrument technicians, mechanics and welder/pipefitters available to both Amy Street and Mill Street as required.

In the event that final site selection is a site other than Mill Street then the 42 personnel may be required. This more conservative assumption has been used in deriving operating cost estimates.

3.5.11 Operations

The new incineration plant operation will be planned so as to receive wastes, normally on a 5-day week basis, while producing steam opn a continuous basis 24 hours per day, 7 days per week. The three major units can be shut down in turn once per year for major maintenance.

The operations staff will work on a 3-shift system, with administration and maintenance on a day-time basis. In addition to the shift chief, shift operating staff include crane operators, foremen and labourers.

3.6 ENVIRONMENTAL ASPECTS

Any waste disposal operation, particularly incineration in a central urban area, has potential for adverse environmental impacts, and both design and subsequent operation must be adequate to prevent these. There are, however, many examples of incineration plants in urban areas, operating perfectly satisfactorily in conformity with regulatory requirements, and without offence to immediate or more distant neighbours.

Principal concerns are:

- air pollution prevention
- liquid effluent control
- disposal of ash
- in-plant dust and odour control
- noise control
- traffic control
- aesthetics
- thermal pollution

3.6.1. Air Pollution Prevention

Refuse is a low-sulphur fuel and does not give rise to high sulphur dioxide concentrations. Despite concerns often expressed, any generation of hydrogen chloride from plastics or other materials also results in very low concentrations. The pollutant of greatest concern is particulate matter. For abatement, combustion gases will be cooled by use in pre-heating combustion iar, then passed through dry electrostatic precipitators, achieving 99% particulate removal efficiency, being finally discharged to the stacks. While each unit will have its individual stack, these can be combined into a single concrete shell stack.

3.6.2 Liquid Effluent Control

Depending on the final design and selection of equipment, liquid effluents may arise from ash quenching or spray cooling, as well as from boiler blow-down. It is anticipated that quality will be such as to permit direct discharge to municipal sewers without pretreatment.

3.6.3 Ash Disposal

All dust and particulates from the grates, boilers and precipitators will be conveyed to the quenching pit, then discharged by ram or belt conveyor (depending on final design) and transported to a truck loading point. From here they will be hauled to the designated sanitary landfill. Site No. 6 has been assumed for the purposes of this report.

Incineration residues are very low in organic content by comparison with raw wastes placed in landfill. The actual content will depend on residence time in the incinerator, and burning temperature. The principal contents are ash, glass, tin cans and other ferrous and non-ferrous metals, stones, bricks and ceramics.

3.6.4 In-plant Dust and Odour Control

The waste receiving and tipping area will be laid out to separate truck and crane operations. Truck discharge to the storage pit will be through individual gates opened only during such actual discharge periods. Combustion air intake will be located in the receiving pit, which is kept under negative pressure to ensure dust and odours are conveyed to the combustion chamber. Odours will be thermally destroyed and particulates carried over dealt with in the precipitators. The handling and transfer of wastes will be minimized and transfer points specially proected as required.

3.6.5 Noise Control

While both refuse tipping and boiler operations are inherently noisy, provision of suitable enclosures and selection of appropriate construction and architectural materials will be undertaken to satisfy both community noise and in-plant noise limitations.

3.6.6 Traffic Control

The number of vehicles required to deliver the annual quantity of waste to a central downtown plant is substantial. It will be necessary to plan the new operation very thoroughly, in cooperation with Winnipeg City Works and Operations Department.

It may be necessary to devise special schedules to spread the delivery time over a longer daily period in order to avoid congestion at Mill Street if this site is selected for plant location.

Allowing 250 working days for refuse collection and haulage, and the load being shared between 8 ton and 5.5 ton per vehicles, the number of vehicles arriving at the incinerator site on a working day could be as high as 250.

3.6.7 Aesthetics

Experience in Europe has shown that refuse incinerator plants can be designed to blend well with their environment, and to be even aesthetically pleasing. Attention should be paid to aesthetics during the planning and design stages, with special reference to the plant location, site characteristics and neighbourhood.

3.6.8 Thermal Pollution

Approximately 660 million lbs. of excess steam will be condensed during the summer months using river water or air, depending on the plant location. Special care will be required in designing the condenser water discharge location to minimize the impact of thermal pollution on the river ecosystem.

No thermal plume is anticipated during winter months as steam demand will exceed the capacity at the incinerator plant.

3.7 COSTS

3.7.1 Capital Cost

The following costs are for the recommended scheme, Alternative 4, with the combined plants serving the existing plus western plus eastern extensions.

	Million $
Incineration plant and ancillaries	73.5
Steam mains and distribution	6.7
Conversions	0.6
Amy Street Upgrading	19.81
Net Capital Cost	100.61

To determine the incinerator construction costs to a study level accuracy, a preliminary list of major equipment was formulated using SNC's data for similar plants. Manufacturers were contacted to update costs, and established installation factors used to determine installed costs. Indirects including: construction indirects; contractor's fee: engineering; and contingencies were added to determine the total cost.

Cost of Incinerator Plant includes:

- construction costs
- steam piping to plant boundary
- plant utility systems, electricity, instrumentation air, fire prevention, etc.
- site development
- roads and parking areas on site
- connection to sewers, water supplies
- engineering

Not included are:

- interest during construction
- working capital

The cost of buildings (not eligible for Federal Government Grant) is $17 million. Allowance has been made for reinforced concrete substructure and an upper building enclosure of industrial steel with galvanized or corrugated asbestos siding.

The steam mains and distribution item includes the extension, but not the cost of upgrading the existing system. All of the Western extension piping will be underground. Steam to industrial area will, in large part, be supplied by an above-ground pipe along the CNR route. As discussed earlier, condensate return has not been assumed for these cost estimates.

Conversion costs are low as most of the potential customers use steam as the heating medium.

Amy Street station upgrading costs include: electrostatic precipitators, replacement of boilers 1-4 by a new boiler, and upgrading of the existing distribution system.

3.7.2 Operating Costs

Operating costs for the major system components are summarized below:

	Million $ per annum
New Mill Street Incineration Plant	4.50
Amy Street Plant	1.81
Fuel Cost (Amy Street)	0.44
Ash Disposal	0.37
Savings in Haulage	(0.72)
Net Operating Costs	6.40

The above are the direct operating costs, which are offset by revenues from steam sales, and tipping fees (see Chapter 4).

The largest single item is the incinerator operating cost which is comprised mainly of manpower, maintenance, auxiliary fuels, and power. Amy Street plant operating costs are based on Hydro data, and fuel costs based on current price and projected average winter peaking demand.

All disposal costs are based as ash quantity 20% of the refuse, and disposal at No. 6 landfill site located 10 miles from the incinerator. Haulage costs, calculated at $0.40/ton mile using City data, have been applied.

Savings in refuse haulage have been calculated as follows:

1. Assume that all waste is diverted to the new incinerator site.

2. Calculated distance to Mill Street site from centre of waste origin. Subtract from distance to landfill site to determine ton-mile savings. Use plus for reduction and minus for increased ton-miles.

3. Calculate haulage costs using City's cost data for the operation of side loader and rear loader machines. Using a road speed of 17 mph and neglecting turnaround time, following haulage costs were determined:

   Side loader = $0.39/ton-mile
   Rear loader = $0.45/ton-mile

4. Calculate savings by multiplying the saved ton-miles with haulage cost.

4.0 FINANCIAL ANALYSIS

4.0 FINANCIAL ANALYSIS

4.1 METHODOLOGY

In our opinion, a present value analysis is the most practical analytical tool for an economic evaluation of a project of this nature. It is also consistent with the objective of this phase of the study, which is to determine whether justification exists in terms of markets and costs to proceed with Phase II. Using the present value method, an analysis of the financial data has been performed to calculate the benefit/cost ratio over the entire life of the project for a Base Case. Effect of various factors on this benefit/cost has been determined. A positive benefit/cost ratio, with a probability of identifying further increases during Phase II of the study would justify a detailed assessment of the project.

Alternative 4 of Chapter 3, which consists of supplying the total markets (existing + Western + Eastern) with steam generated primarily from municipal wastes has been used for the financial analysis. A number of benefits including the revenues and savings to the system and various levels of governments, have been included in the base case along with the capital and operating costs determined in Chapter 3. The range in which the benefit/cost ratio could lie has been calculated by considering possible cost escalations and variations in benefits. Additional benefits that could be available to the system have also been outlined.

4.1.1 Definitions

Present Value of Benefits or Costs:
This consists of a sum of discounted annual benefits/costs over the life of the facility.

Net Present Value:
The net present value is the total present value of all benefits less the total present value of all costs.

Benefit/Cost Ratio:
Benefit/Cost ratio is the ratio of total present value of all benefits to the total present value of all costs.

4.1.2 Calculation of Present Value

The most important single parameter in determining the present value of future costs and benefits is the discount factor. Wood Gundy has advised the City that the real cost of money to the City is 4 percent per annum. If this figure is used as a discount rate in the present analysis, the effect of inflation will be automatically taken into account thus obviating the need to speculate on future rate of inflation.

The method of calculating the present value of capital costs is demonstrated by the following example.

- The capital cost of the Mill Street Plant in 1982 is 73.5 million dollars.

- The expenditure will take place in 1988.

- The cost will still be 73.5 million in 1988 if inflation is omitted.

- The 73.5 million dollars discounted to 1982 at 4% per annum is $58.09 million (if 58.09 million is invested at 4% per annum the yield will be 73.5 million in 1988).

Present value of annual costs and benefits are a summation of yearly costs over the period in question calculated on the same basis. It is assumed that the plant will start up in 1989.

The above analysis is valid if all costs are affected by inflation at the same rate and we have used the 4% figure as a general discount rate. We have, however, made allowance for the fact that oil and gas costs will increase at a rate higher than the general rate of inflation, at least until 1986.

4.2 ANALYSIS

This section presents a benefit/cost analysis of the base case, determines the effect of the range of accuracy of cost estimates on benefit/cost ratio, and outlines possible additional benefits.

A financial analysis of coal as a fuel is also presented.

4.2.1 Base Case

The Base Case consists of supplying total (existing + Eastern + Western) markets with steam generated in a refuse incinerator. Winter peaking steam is supplied by the Amy Street station using coal as a fuel. Costs and benefits included in the base case are discussed and present values calculated in the following sections.

Costs

The capital and operating costs for the Base Case have been presented in Chapter 3, and are further discussed in Appendix D. These are also summarized in Table 4.1. The net present value of costs is $174.76 million.

Benefits

Table 4.2 presents the capital and annual benefits to the facility and their present value. Total present value of all benefits is estimated at $225.9 million. The largest single benefit to the project is the revenue generated from the sale of steam.

The price of steam used in this analysis is based on a current market price of $5.20 per thousand pounds. This price is related to the price of oil and gas, both of which will increase at a higher rate than the general inflation. On the basis of the National Energy Board Policy and the current annual rate of inflation, this has been calculated to be 4.2% per year above inflation.

TABLE 4.1

BASE CASE COSTS

	1982 Million Dollars	Present Value Million Dollars
Capital Costs		
Amy Street Plant	19.81	15.81
Mill Street Plant	73.50	58.09
Distribution System	6.70	5.30
Startup Costs	2.00	1.58
Conversions to Steam	0.60	0.47
Total	102.61	81.25

	Million Dollars per year	Present Value Million Dollars
Operating Costs		
Amy Street Plant	1.81	23.78
Coal	0.44	5.74
Mill Street Plant	4.50	59.13
Ash Disposal	0.37	4.86
Total	7.12	93.51*
TOTAL ALL COSTS		174.76

* Life assumed at 30 years.

Increasing the current market price of steam of $5.20 per thousand pounds by this rate until 1986 gives a market price (1982 dollars) of $6.13/thousand pounds. This price has been used in this analysis. It has been assumed that the price of gas and oil will increase at the same rate as inflation after 1986. While this is probably overly conservative, there is no basis for making any other assumption.

Because building heating tends to be less efficient than steam generation for industrial process uses, a higher price could be charged for steam for heating purposes. This could be achieved by charging a higher price for winter steam and a corresponding lower price in summer, resulting in the same annual cost to industrial users. A low summer price would tend to encourage consumption of surplus steam during this period. In our opinion a 10% higher price in winter would be acceptable to the commercial customer, and would not reduce the projected market. This price structure would result in a net revenue of $123.91 million expressed as present value over the life of the facility.

A number of benefits will result from the construction of the proposed systems. These are described below and methods and basis of calculation are presented in Appendix D.

- A Federal government grant under the F.I.R.E. 2 (Forest Industry Renewable Energy) program is available for facilities recovering energy from municipal wastes.

- A replacement for District 4 landfill (expected to be full by 1989) would not be required. Also, District 2 landfill could be closed. This will result in both capital and operating cost savings.

- Expenditure for heating Federal, Provincial and City buildings currently served by district heat (required if the existing system closes) would not be needed. Also, the operating costs for these heating facilities (excluding fuel) will be avoided.

TABLE 4.2

BASE CASE BENEFITS

Capital Benefits	1982 Million $	Present Value Million $
F.I.R.E. 2 Grant	16.42	12.98
Replacement for District #4 Landfill not required	5.00	3.80
New heating equipment for Federal, Provincial, City buildings not required	4.65	3.58
Electrical equipment by Hydro for serving customers converting to Electric Heat not required	5.53	4.93
Subtotal	31.60	25.29
Annual Benefits		
Revenues from Steam Sales	9.43	123.91
Haulage Cost Reduction	0.72	9.46
Landfills #2 and #4 not required	2.14	28.12
Operation of new heating systems at Federal, Provincial and City Buildings not required		17.04
Fuel cost savings to Federal, Provincial and City Governments	0.63	8.30
Increased Tipping Fee from Industrial Haulers		9.46
Avoidance of Hydro Losses for supplying power to present customers converting to Electric Heat		4.38
Subtotal		200.67
TOTAL BENEFITS		225.96

- The cost to Hydro of expanding electric services to include those buildings converting to electric heat, if the Amy Street Plant closes, would not be required. Winnipeg Hydro also expects to lose money by providing electricity to these clients for heating. For this estimate, it is assumed that 25% of existing customers will convert to electricity.

- There would be a net reduction in municipal solid waste haulage costs.

- The lower projected steam cost for the proposed system will result in reduction in fuel costs for the three levels of government.

- An increase in tipping fees to industrial users is justified to recover a saving of $720,000/year to industrial waste haulers because of the central location of the facility.

Benefit/Cost Ratio

The net present value of costs and benefits are:

Net Present Value, Benefits	$225.96 million
Net Present Value, Costs	$174.76 million

Thus the net present value of the project is $51.70 million and the benefit/cost ratio is 1.29.

TABLE 4.3

EFFECT OF RANGE OF ACCURACY ON BASE CASE BENEFIT/COST RATIO

	Present Value (Million dollars)	
	High	Low
Costs		
Capital - Incinerator Plant and Distribution	78.53	49.08
Existing System Modifications	15.81	15.81
Annual - Incinerator Plant	76.74	47.99
Amy Street Plant	23.78	23.78
Coal	5.74	5.74
Subtotal	200.60 (a)	142.40 (b)
Benefits		
Capital - F.I.R.E. 2 Grant	15.78	11.35
Landfill not required	3.80	3.80
Conversion to electricity	6.89	2.89
New heating equipment	4.30	2.69
Annual - Haulage	11.35	7.10
Landfill Operation	28.12	28.12
Hydro Loss - Electricity Conversion	5.58	2.71
Lower fuel cost	8.30	8.30
Operating Cost of Heating System	20.45	12.78
Increased tipping fee for Industrial haulers	11.35	7.10
Revenue	123.91	123.91
Subtotal	239.83 (c)	210.75 (d)
Benefit/Cost ratio	$= \frac{c}{b}$	$= \frac{d}{a}$
	= 1.68	= 1.05

Effect of Accuracy Range on Benefit/Cost Ratio

Table 4.3 presents the effect of the range of accuracy of the following costs and benefits on the net present value of the project:

1. The range of accuracy of capital and operating costs for the incinerator and the distribution system is -25, +20%. The same range of accuracy is applicable to the savings in haulage cost and increased tipping fee to industrial haulers. The F.I.R.E. 2 grants also vary with the incinerator capital costs.

2. Another factor, which has a significant cost impact, is the number of the existing customers that could convert to electricity as a result of Amy Street plant closure. Rate of conversions is assumed at a minimum of 15% and a maximum of 35%.

   No accuracy range has been applied to the costs and benefits provided by Hydro and the City Waterworks, Waste and Disposal Department, as their costs are based on present experience and detailed studies. The exception is the capital and operating costs of heating the Federal, Provincial and City buildings presently serviced by the district heating system.

The highest net present value of benefits is $239.83 million, and the lowest net present value of costs is $142.40 million, resulting in a high net present value of $97.43 million, and a high benefit/cost ratio of 1.68.

The lowest net present value and benefit/cost ratio are calculated at $10.15 million and 1.05 respectively.

These factors will increase further if a number of additional benefits, described in the following sections, are included in the analysis.

Potential cost increases due to a site other than Mill Street, or cost of meeting stringent environmental requirements than foreseen in this study, could have a negative impact on the benefit/cost ratio. These factors should be considered in detail during Phase II of the study.

4.2.2 Potential Benefits not included in the Base Case

A number of potential benefits, not included in the base case, could further enhance the net prevent value of the project. These include:

- Additional industrial markets, e.g. Building Products, or future development in the area, could be served if satisfactory peaking arrangements can be made. Serving Building Products results in a net increase in revenue of $890,000 per year for a capital investment of approximately 1 million dollars.

- There may be some benefit to be derived from the use of steam in summer for the generation of electricity or for the production of chilled water for air conditioning via absorption machines. Both of these appear to represent marginal benefits, but detailed assessment is required during the second stage.

- Availability of low cost steam during the summer may attract industries to Winnipeg. If realized, this would provide economic stimulation and result in additional revenues to the City.

- A probable higher cost of alternative fuels than forecast could justify an increase in the price charged for steam. Any attempt to forecast the price of natural gas or oil beyond 1986 is speculative. However, if the price of these fuels continues to increase at the same rate above inflation to 1989, the price charged for steam could be increased to yield approximately $1.26 million per year more.

- We have allowed for normal inplant usage of steam of 20% of annual production and pipeline losses of 20% of annual sales, which corresponds closely with Canadian experience in district heating systems. However, European experience suggests that these factors can be reduced by more than 50% in the more modern systems with condensate return and pre-insulated pipe distribution systems.

- A condensate return system will require a substantial capital investment and has not been considered for this phase of the study. A well insulated distribution system could result in line losses in the order of 7-1/2%, which would reduce the cost of coal by approximately $139,000/year.

The above estimates have not been examined in detail and therefore must be considered very approximate.

4.2.3 Coal as a Source of Energy

A present value analysis of an expanded district heat system using coal as a source of energy shows that the project would have a negative net present value. Coal (and obviously other more expensive fuels) are not, therefore, practical fuels for use in the proposed system.

Table 4.4 shows the costs and benefits of a coal-fueled system in terms of present value and shows a negative net present value of $8.82 million.

As a result of this analysis, no detailed investigations were undertaken into the use of coal or any other fossil fuels.

TABLE 4.4

COAL AS A SOURCE OF ENERGY

	Present Value (Million dollars)
Costs	
Capital - Amy Street Upgrading	15.81
Distribution System	5.06
Steam Conversions	0.47
New Boilers	3.16
Operating	58.81
Coal	87.65
Subtotal	170.96
Benefits	
The heating equipment not required for government buildings served by existing system	3.58
Electric equipment by Hydro for serving customers switching to electricty not required	4.93
Revenues	123.91
Heating systems operating costs not required	17.04
Heating cost saving to various governments	8.30
Avoidance of losses to Hydro incurred by selling electricty for heating	4.38
Subtotal	162.14
Net Present Value (Negative)	(8.82)

NOTE:

Operating costs based on existing Hydro operating costs. It has been assumed that operating labour and administration costs do not change and that all other costs increase in proportion to steam production.

4.3 CONCLUSIONS

The base case indicates a viable project when direct benefits are taken into consideration. It appears that viability can be further increased when other possible benefits, which have not been studied in detail, are taken into consideration.

Thus, it is concluded that justification exists for proceeding with the Phase II of the study.

Coal, or other fossil fuels, are not a practical alternative to municipal solid waste as a source of energy.

APPENDIX A

TERMS OF REFERENCE

1.0 PROJECT

The City of Winnipeg desires to undertake a study into the economic viability of district heating for the central area of the City of Winnipeg, utilizing municipal waste and other energy sources that are considered readily available to reduce dependency on critical non-renewable fuels.

2.0 BACKGROUND

The City of Winnipeg has been operating a District Heating System serving the central area of the City since 1924. Several studies have been undertaken to review and confirm present and projected operational and financial status of the district heating system. One particular study identified that an economic balance could exist between the burying of the City's incinerable solid wastes and its use for heat recovery. The recommendation of these studies indicated the need to explore the technical and financial feasibility and further determine the economic viability of district heating considering solid waste as one source of energy.

To proceed with this recommendation the City of Winnipeg obtained the approval of a cost sharing study into the economic viability of District Heating in the central area of the City under the Manitoba-Canada Agreement on the Development of Renewable Energy and Energy Conservation Technologies.

It was decided that the complete study would be undertaken in two phases and that the first phase would encompass aspects of the study required to confirm whether existing and potential markets for district heating can be established at an acceptable cost.

3.0 SCOPE OF THE COMPLETE STUDY

The overall cost of the complete study shall not exceed $700,000.00 and will encompass the following elements:

(1) A technical and financial review of all relevant reports on district heating, waste disposal and energy recovery.

(2) An assessment of the market potential for district heating in relation to alternative energy resources and energy systems.

(3) Development of conceptual plant and distribution system design, which would encompass site selection criteria, primary fuels, system configuration and social and environmental impact.

(4) An evaluation of the economics of cogeneration and other market potentials that would optimize annual load profile.

(5) An evaluation of the economics of use of solid municipal waste and other alternative energy resources.

(6) Evaluation of ancillary facilities for the disposal of hazardous wastes.

(7) An assessment of the condition of the existing steam heat distribution system and an evaluation of the upgrading or the replacement of the existing steam mains.

(8) An assessment of the costs of either upgrading the existing district steam heat plant or providing for a new heating plant at the existing site or elsewhere.

(9) Preparation of master implementation plan including a cost staging, if appropriate.

(10) Prepare a formal Study Report, Executive Summary and a visual aided formal presentation.

4.0 SCOPE OF PHASE I STUDY

Phase I of the study will be undertaken at a cost not to exceed $50,000.00 and will encompass all aspects of the complete study required to confirm within a reasonable degree of confidence, that existing and potential markets for district heating are available and can be supplied at acceptable cost.

It is intended that the Phase I study will include as a minimum a preliminary market study to obtain analysis of existing and potential customers. However, the Consultants are invited to provide in their proposal any other supportive aspects they would include so that the final report will provide recommendations on the economic viability of district heating in sufficient detail to make a decision on whether to proceed with the second phase of the complete study.

The Consultant shall furnish all engineering services required in connection with the project, including those required for administration, schedule control, drafting, writing, programming, accounting, inspection and scientific research. The services shall include the provision of all staff necessary to do the work, to be arranged in accordance with a program to be drawn up by the successful Consultant at the beginning of the project, in conjunction with the representatives of the City of Winnipeg. This program, when approved by the City of Winnipeg shall govern the work.

The approved program and the progress of the studies in relation to the program, shall be compared in order to gauge the adequacy of the staff complement and the skill effectiveness of the Consultant's organization. If the schedule control system predicts deviations from the approved program, or any subsequently approved variation of it, such predictions shall be the main criteria for planning the ongoing size and skill content of the Consultant's force.

Proposals should identify and include full data on senior personnel that will be assigned to the project team and any particular specialist (internal or external to the Consultant) that could be assigned any portions of, or during any particular phase of the study.

Proposals should include full data on support facilities that will be used, including such things as a comprehensive library, computer and laboratory facilities or any other special engineering or scientific affiliation that adds to the Consultant's credibility for this work.

5.0 TERMS OF REFERENCE

The prospective Consultants will include a detailed Terms of Reference with their proposal that they would recommend be followed for the first phase of the study and the amount of time to be spent on major elements of the project with the understanding that they will be required to complete all details as submitted in the Terms of Reference.

The selected Consultant will be required to provide twenty-five copies of their final report complete with executive summaries and will be prepared to make one formal presentation.

APPENDIX B

WINNIPEG HYDRO

MR. K.H. HALLDORN, P. ENG.
GENERAL MANAGER
5TH FLOOR, ADMINISTRATION BLDG.
CIVIC CENTRE
WINNIPEG, MANITOBA R3B 1C1
TELEPHONE: 949-1100

1982 08 10

Dear

Several hundred cities throughout Europe and North America have established municipal solid waste burning facilities and are using the energy produced to generate steam. This steam is being distributed to major steam or hot water users in the area and is resulting in a reduction in building heating costs.

Winnipeg Hydro currently owns and operates a steam distribution system which supplies steam to over 200 customers in downtown Winnipeg. At present coal is used to generate steam, but we are investigating the feasibility of expanding the system and burning Winnipeg refuse as a source of energy.

If this is feasible, we will be able to reduce heating, and possibly air conditioning costs, to the owners of buildings and industrial facilities in Winnipeg, while at the same time reducing solid waste disposal costs and fossil fuel consumption.

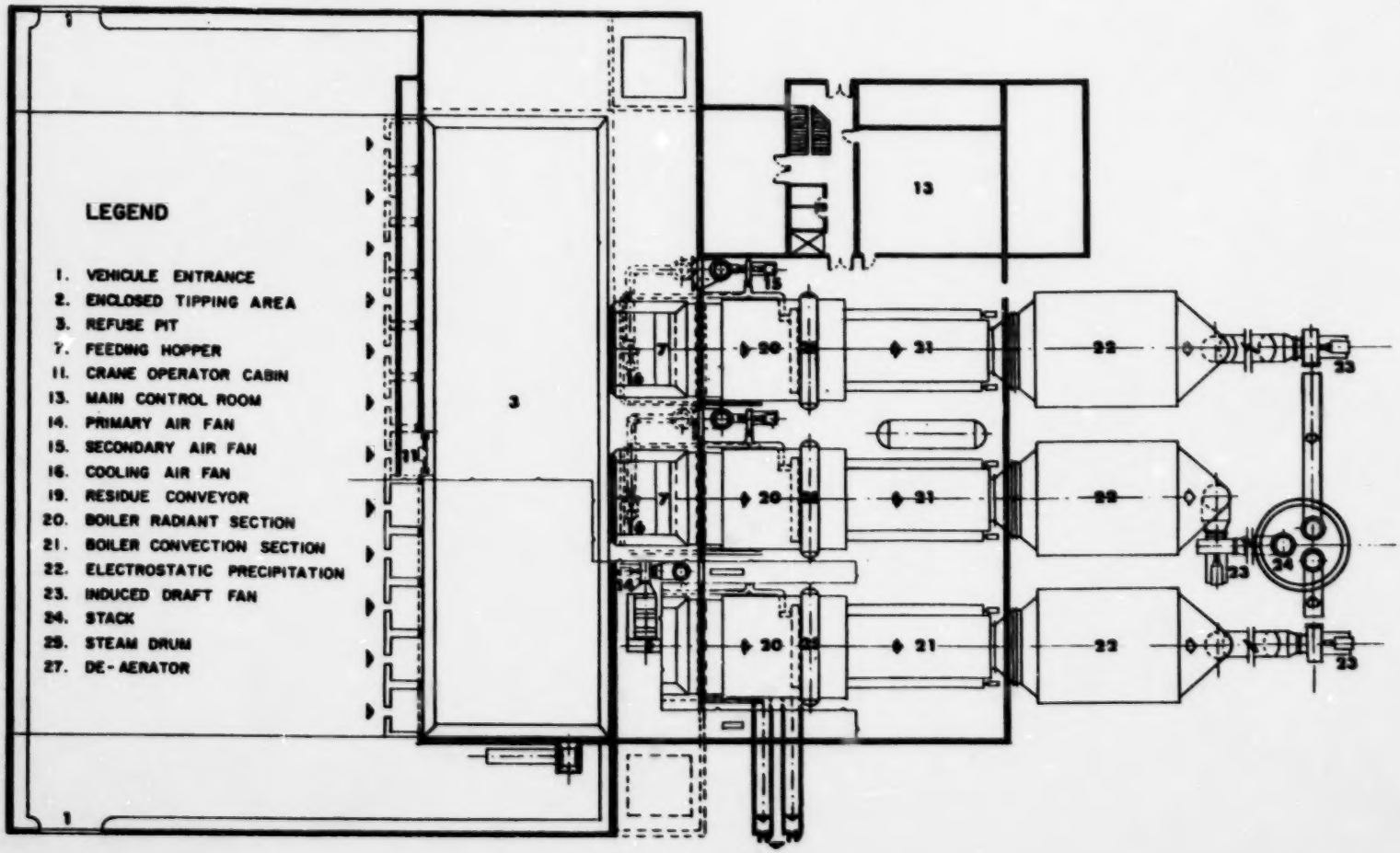
The City of Winnipeg has retained consultants (S.N.C./Wardrop) to determine the level of interest amongst major energy consumers in and around downtown Winnipeg. It would be appreciated if you could assist them by providing details of your energy consumption during 1981 and allowing a representative to examine your building heating plant. This representative will be contacting you in the next few days to arrange for a convenient time when the project can be discussed in more detail and to outline some areas where overall heating costs might be reduced.

We all realize the importance of conserving non-renewable energy and your co-operation in this matter would be greatly appreciated. This project is not only of great importance to the City of Winnipeg but could result in a saving to your company in reducing your operating costs.

Yours truly,

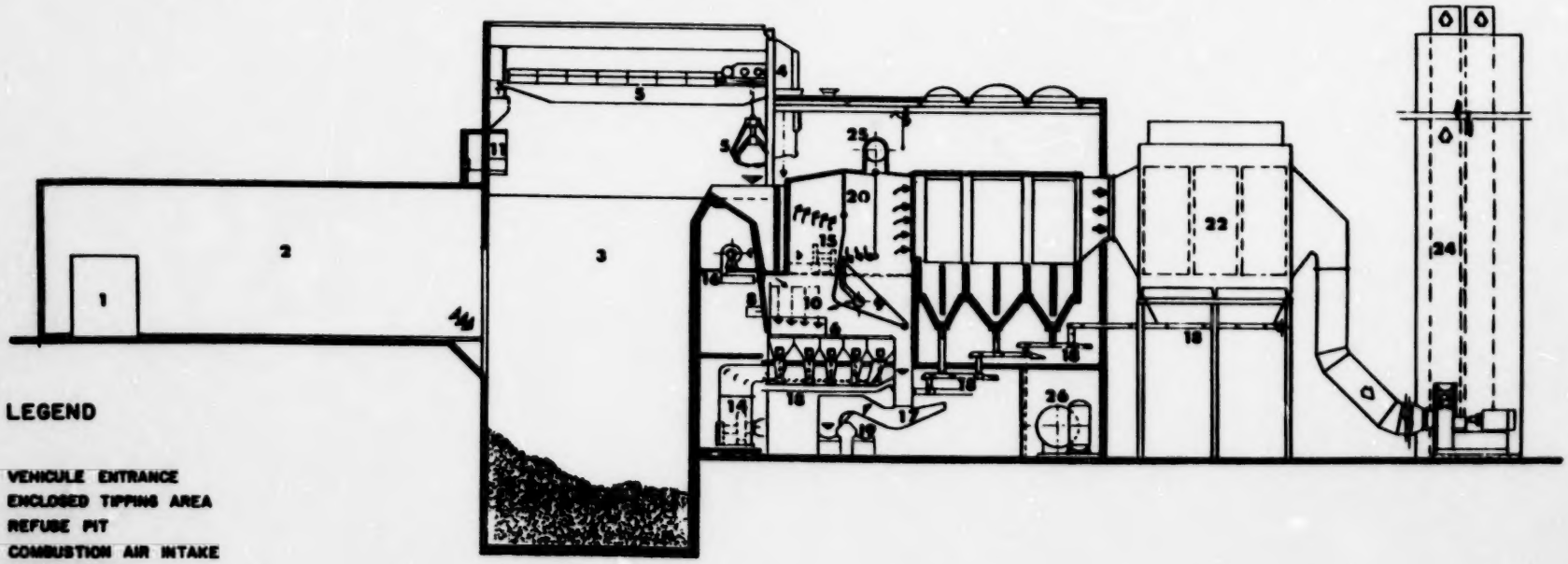
General Manager

APPENDIX C



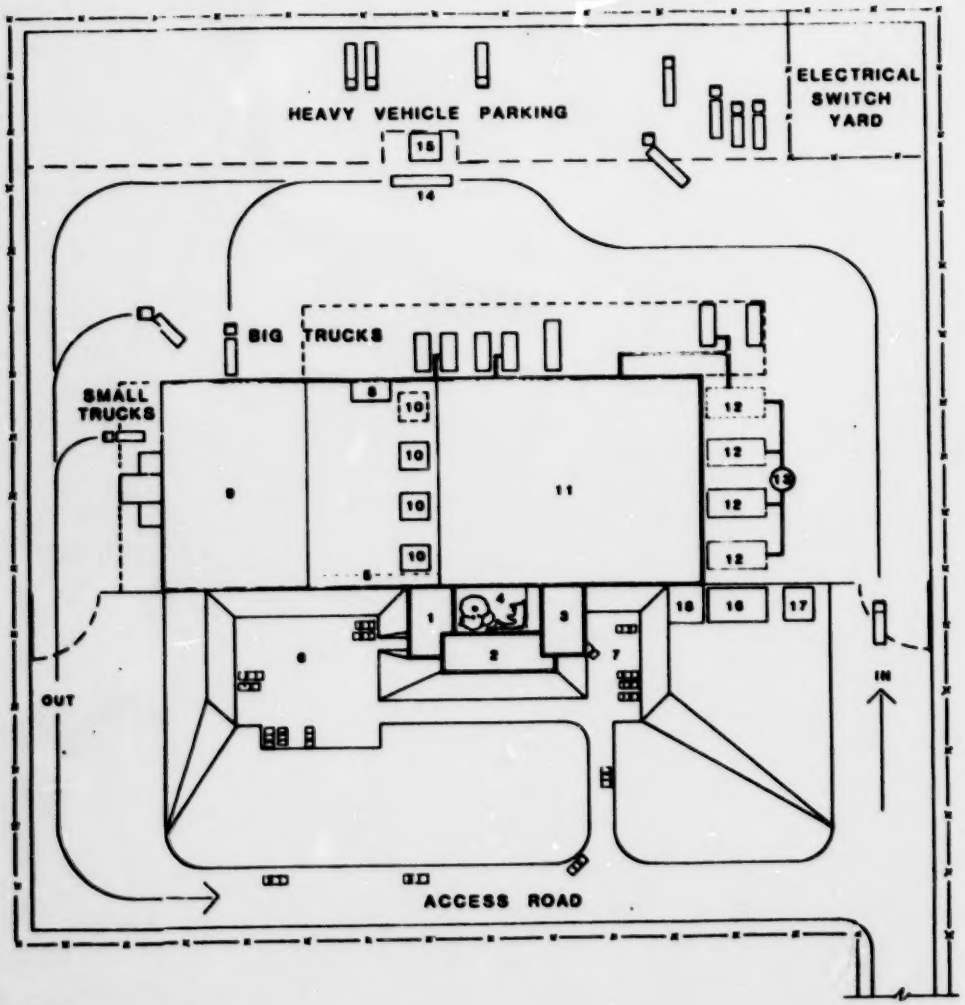
TYPICAL PLAN

TYPICAL SECTION



LEGEND

1. VEHICULE ENTRANCE
2. ENCLOSED TIPPING AREA
3. REFUSE PIT
4. COMBUSTION AIR INTAKE
5. CRANE / GRAB
6. HORIZONTAL GRATE
7. FEEDING HOPPER
8. RAM FEEDER
9. SECONDARY AIR SUPPLY
10. COMBUSTION CHAMBER
11. CRANE OPERATOR CABIN
12. FEEDING CHUTE
13. MAIN CONTROL ROOM
14. PRIMARY AIR FAN
15. SECONDARY AIR FAN
16. COOLING AIR FAN
17. RAM DISCHARGER
18. GRATE SIFTING & DUST CONVEYOR
19. RESIDUE CONVEYOR
20. BOILER RADIANT SECTION
21. BOILER CONVECTION SECTION
22. ELECTROSTATIC PRECIPITATION
23. INDUCED DRAFT FAN
24. STACK
25. STEAM DRUM
26. BOILER FEED WATER TREATING
27. DE - AERATOR



TYPICAL SITE LAYOUT

LEGEND

1. PERSONNEL
2. ADMINISTRATION
3. VISITORS
4. GARDEN
5. OVERHEAD GALLERY
6. PARKING: PERSONNEL
7. PARKING: VISITORS
8. OPERATORS
9. RAW REFUSE STORAGE
10. FEED CHUTES
11. BOILERS
12. PRECIPITATORS
13. STACK
14. SCALE
15. SCALE HOUSE
16. BOILER SERVICE
17. OIL STORAGE
18. TURBO-GENERATOR

APPENDIX D

APPENDIX D

Source of Data & Assumptions:		Source
Market	1465 million lbs. per year	Chapter 2
Current Market Price for steam	$5.20 per thousand lbs.	Chapter 2

Capital Costs

Mill Street Plant	$72.00 million	Chapter 3
Western Distribution System	3.25 "	"
Eastern Distribution System	3.15 "	"
Pipeline Mill St. to Amy St.	0.30 "	"
Site Development	1.50 "	"
Conversions (H.W. to steam)	0.60 "	"
Start-up Costs	2.00 "	"
Upgrading Existing Distribution System	9.00 "	"
Electrostatic Precipitators	3.20 "	"
Replace Boilers 5 and 6	2.25 "	"
Amy Street Modifications	5.36 "	"

Operating Costs

Mill Street Plant	$4.5	million/yr	Chapter 3
Ash Disposal	0.37	"	"
Amy Street			
Operating Labour	0.45	"	"
Maintenance Labour	0.26	"	"
Plant Material	0.34	"	"
Distribution Labour & Material	0.40	"	"
Commercial & Administration	0.35	"	"

Capital Cost Credits

New heating plant required by City if Amy Street closes	$1.17 million	Winnipeg Hydro
New heating plants required by Federal and Provincial buildings	$3.48 million	Prorated from steam demand and Hydro cost estimates for City
New landfill site not required to replace Springfield Road	$5.00 million	Waterworks, Waste & Disposal

F.I.R.E. 2 Grant - 20% of capital costs not including buildings, land or interest.

Land

The value of land has not been taken into consideration in this analysis. In terms of present value, if the land is taken as an initial cost it would be taken as a benefit after the life of the project. The net effect is zero. A possible higher value use of the land (e.g., the social value of riverbank parkland) has not been taken into consideration.

Operating Cost Credits

Haulage Saving	$0.72	million/yr	Chapter 3
Landfill Operating Costs #4 & #2 closed	$2.14	"	Winnipeg Hydro
Additional cost of heating City-owned building if Amy Street closed	$0.25	"	
Additional cost of heating Federal and Provincial buildings	$0.75	"	Prorated based on steam consumption as Hydro data for City.

Costs to Winnipeg Hydro of existing customers converting to electric heat

Capital	15% of customers converting	$3,320,000	Winnipeg Hydro
	25% of " "	5,534,000	"
	35% of " "	7,747,000	"
Operating	15% (Present Value over 40 yrs)	$2,712,000	"
	25% " " " " "	4,375,000	"
	35% " " " " "	5,581,000	"

Projected Increase in Price of Natural Gas

Feb. 1/83	5.1%	Greater Winnipeg Gas
Aug. 1/83	12.5%	"
Feb. 1/84	6.0%	"
Aug. 1/84	9.8%	"
Feb. 1/85	5.0%	"
Aug. 1/85	6.8%	"
Feb. 1/86	6.4%	"
Aug. 1/86	7.1%	"

Projected Increases in Price of Oil

	Old $ per barrel	Blended $ per barrel
1982	24.62	31.77
1986	42.67	52.06

Dept. of Energy, Mines & Resources

Accuracy of Cost Data

1. Assume Hydro data accurate

2. Chapter 3 data - 25% + 20%

Price of Coal

Lignite	$27.85/ton	Winnipeg Hydro

Coal Required at Amy Street

0.109 tons lignite per thousand pounds steam.
Calculated from data provided by Winnipeg Hydro.

Financial Assumptions

Present Value:

Use 4% discount rate and zero inflation — Winnipeg Hydro
30 year life of plant

Assume all capital for Mill Street spent in 1988.

Assume startup in 1989.

Pipeline Losses

Steam delivered and sold Canadian systems 1981.

	Steam delivered million lbs.	Steam sold million lbs.
Toronto	1168	963
Vancouver	766	653
Winnipeg	414	330

Source: Modern Power and Engineering, August/82

Based on the above data, an average loss of 20.7% of sales has been calculated; 20% is used in this analysis. Losses have been assumed to be constant, year round.

Monthly Load Profile

The System Curve (Fig. 3.1) was prepared based on the following data:

The monthly variation in demand for the western extension follows the same pattern as the existing system.

Industrial and commercial load variation provided by users.

Steam production at Mill Street 3.15 lbs/lb. Municipal Solid Waste (MSW).

Mill Street in-plant efficiency 80%.

Price of Steam

The current market price of steam is $5.20/thousand pounds which is related to the price of gas and oil.

Gas and oil will increase in price to 1986 as a result of the National Energy Program.

On the assumption that oil represents 20% of the usual fuel bill the average increase in fuel bills will be 1.15% per year.

The current rate of inflation is 10.8% (July 1981 to July 1982 for Canada). If the rate of inflation remains constant, the cost of fuel will increase at 4.2% above the rate of inflation until 1986.

Increasing the current market price of steam of $5.20 per thousand pounds by this rate until 1986 gives a price (1982 dollars) of $6.13/thousand pounds.

This price has been used in this analysis. It has been assumed that the price of gas and oil will increase at the same rate as inflation after 1986. While this is probably overly conservative, there is no basis for making any other assumption.

POOR

QUALITY

ORIGINAL